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MASSACHUSETTS AGRICULTURAL COLLEGE

REPORT OF THE PRESIDENT

AND OTHER OFFICERS OF ADMINISTRATION

1920

PUBLIC DOCUMENT No. 31

THE M. A. C. BULLETIN

AMHERST, MASSACHUSETTS

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THE FIFTY-EIGHTH ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE

PART I.—THE REPORT OF THE PRESIDENT AND OTHER OFFICERS OF ADMINISTRATION FOR THE FISCAL YEAR ENDED NOV. 30, 1920

DEPARTMENT OF EDUCATION
THE COMMONWEALTH OF MASSACHUSETTS

Publication of this Document
approved by the
Supervisor of Administration.

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The Commonwealth of Massachusetts

Department of Education, Boston, Feb. 15, 1921.

To the Honorable Senate and House of Representatives.

Gentlemen: — In accordance with the provisions of section 32 of chapter 30 of the General Laws, I transmit to you herewith, for the use of the General Court, the annual report of the Massachusetts Agricultural College for the year ending Nov. 30, 1920.

Respectfully yours,

PAYSON SMITH,
Commissioner of Education.

120/26

The Commonwealth of Massachusetts

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, NOV. 30, 1920.

To the Commissioner of Education.

SIR: — On behalf of the trustees of the Massachusetts Agricultural College I have the honor to transmit herewith Part I of the fifty-eighth annual report of the trustees, for the fiscal year ended Nov. 30, 1920, this being the report of the president of the college and other officers of administration to the corporation.

Respectfully yours,

KENYON L. BUTTERFIELD,
President.

CONTENTS.

PAGE

Report of the President of the College: —

Review of the Year, ... 9

Legislative Budget for 1921, ... 25

The College at the Cross Roads, ... 29

Reports of Other Administrative Officers: —

Report of the Dean, ... 43

Report of the Director of the Experiment Station, . . . 46

Report of the Director of the Extension Service, ... 50

Report of the Director of the Graduate School, ... 53

Report of the Director of Short Courses, ... 61

Tables and Statistics, ... 66

Report of the Treasurer, ... 82

REPORT OF THE PRESIDENT OF THE COLLEGE.

Gentlemen of the Corporation.

I herewith submit my annual report as President of the Massachusetts Agricultural College for the year ending Nov. 30, 1920, and with it transmit reports from other administrative officers of the institution.

REVIEW OF THE YEAR.

The Problems of the Last College Year.

The collegiate year ending last June proved to be probably the most difficult the College has had to pass through in a long while. The war completely upset student life and even made serious inroads in the established procedure of the College staff. The morale and traditions of student work and activities had to be reconstructed. Athletics and other student activities had been in abeyance nearly three years. Two-thirds of the senior class was composed of students whose college career had been interrupted one or two years. Military drill was not popular with the men who had served in the army. The established lines of campus leadership had been broken or had disappeared. An unexpectedly large number of two-year students were brought into a college which had been "geared" to four-year work. The presence of soldier students sent by the Federal Board for Vocational Education, most of whom could not enter four-year courses, added another complication to the campus problems. The increase in women students brought at once to the front relations between men and women in the various phases of student government and life.

However, by the end of the year most of these problems were satisfactorily adjusted, and the new college year began in September with a fine feeling of co-operation and enthusiasm. The College is now operating upon a basis as nearly normal as could be expected.

Great credit is due to the students themselves, who through their own initiative helped to bring order out of chaos and a new spirit of co-operation out of many discordant elements. The faculty, as usual, has responded to the emergency, although laboring under great personal as well as official discouragements.

Change in Trustees.

On Dec. 1, 1919, Dr. Arthur W. Gilbert succeeded Mr. Wilfrid Wheeler as Commissioner of the State Department of Agriculture, and consequently became a member of our Board of Trustees. Mr. Wheeler had been a member of the Board for nearly six years. Dr. Gilbert is a graduate of the College of the class of 1904, and brings to us the benefit of many years of successful experience in leadership in various agricultural activities.

Resignations.

Elsewhere in this report will appear a discussion of the number of resignations which have occurred during the year, and of the effect of these resignations upon the work of the College. Special mention should be made, however, of the resignations of at least three of our men.

Prof. John C. McNutt, who since January, 1916, had been head of our Department of Animal Husbandry, resigned during the summer in order to accept a position as eastern representative for the American Short-Horn Breeders' Association. Professor McNutt was a good teacher, popular not only with his students but also with the farmers of the State. He was particularly interested in stock judging, and developed among our students judging teams who always competed most creditably with similar teams from agricultural colleges all over the country. Professor McNutt did much to improve the live stock of the College, and secured by gift many valuable animals.

Prof. William D. Clark resigned as professor and head of the Department of Forestry, having served in this position since 1912. Since that time the Mount Toby demonstration forest was secured, and under Professsr Clark's direction the plans for forest management of that area were begun. During the war Professor Clark served most acceptably as an assistant in the office of the Fuel Administrator for New England.

Prof. Robert W. Neal, who had been connected with the College since 1906, resigned in order to associate himself with the Home Correspondence School of Springfield. Professor Neal, during the early years of his service here, devoted his time to the teaching of English; later, as the field of agricultural journalism developed, Professor Neal was most active and successful in stimulating interest in this important study. Since the major in rural journalism was established he has had, each year, a group of men who became intensely interested in this work, and who, under Professor Neal's direction and inspiration, received excellent training. Professor Neal is the author of a number of important books.

New Appointments as Department Heads.

Attention should be called to the appointment of Mr. Sidney B. Haskell as director of the Experiment Station. Mr. Haskell is a graduate of the College of the class of 1904, and from the time of graduation until 1916 he was continuously associated with the College. The position in which he latest served us was that of professor of agronomy and head of the department. He was regarded by students and faculty alike as one of the most competent teachers of our staff, and was considered by the farmers of the State as one of our soundest and ablest authorities on questions of practical agriculture. From 1916 to 1920 Mr. Haskell was associated with the National Fertilizer Association, in which work he not only rendered service which brought the highest praise from his associates, but also made contacts throughout the country which greatly broadened his knowledge of agricultural affairs. Mr. Haskell in returning to the College has the full confidence and respect not only of his associates here, but also of the many alumni who are acquainted with him, and of the practical farmers of the State.

Mr. S. M. Salisbury was chosen to succeed Professor McNutt as head of the Department of Animal Husbandry. Mr. Salisbury graduated from the Ohio State University in 1913, and has had several years' successful experience in animal husbandry. He was instructor at the North Carolina Agricultural College from 1913 to 1915; assistant professor at Ohio State University from 1915 to 1918; and served as county agent for Medina County, Ohio, from 1918 to 1920.

Mr. Laurence R. Grose was chosen as head of the Department of Forestry to succeed Prof. W. D. Clark. Professor Grose graduated from Brown University and Harvard Forestry School, and has had ample experience as a teacher and in practical work in forestry.

Enrollment of Students.

In the Regular Courses. — This autumn the enrollment of students in work of collegiate grade is 506. The entering class numbers 135, as compared with 125 in 1919. The enrollment in the graduate school is 48, there are 23 special and unclassified students, and 435 in the four-year course. There are 27 women students enrolled in the four-year course, 7 in the graduate school, and 3 as special or unclassified students, making a total of 37 doing work of college grade as compared with 30 in this classification a year ago.

In the Two-year Course. — The work of the two-year course is now well established and the course is continuing to meet with enthusiastic approval among the people of the State. This fall is the first year which finds us with two full classes enrolled in this course. In the autumn of 1919, 191 students enrolled in the first year of the two-year course. This autumn 133 of these have returned for the second year's work; in addition, a number of those who entered a year ago have, during the year, transferred to other courses. One hundred and forty-two have this autumn enrolled in the first year of the two-year course; 19 are registered in the special vocational poultry course; and there are 50 in the unit courses, organized primarily for those soldiers and sailors who cannot meet the requirements of the regular two-year course. Of the 277 two-year students 22 are women.

In the Summer School and Other Short Courses. — The Summer School of 1920 brought to the College more students than any similar course in the history of the College. There were 186 enrolled in the regular four and six weeks' school, and 136 others registered in other courses organized for the summer months. For the second year the courses of the Summer School were developed in co-operation with the State Department of Education, and served as a training school for teachers of western Massachusetts and for others desiring special training in agriculture.

There were 112 enrolled in the Winter School of 1920. The total number of students enrolled in the Short Courses during the year was, including 23 who graduated in 1920, 727. This total suggests the extent to which the College is, through its various short courses, reaching the people of the State who are interested in agriculture, and it should be noted that the majority of those enrolled in all courses, except the Summer School, are interested in agriculture because of their purpose to return to the farm.

Disabled Soldiers as Students. — During the year the College has continued to co-operate with the Federal Board for Vocational Education in the training of a large number of disabled soldiers and sailors desiring an education in agriculture. During the year approximately 300 men have been in the College under the provisions of this co-operative plan, some of these remaining a month or two, while others have enrolled in both the two-year and the four-year courses.

Total Enrollment. — The total enrollment at the present time is 845, of whom 506 are enrolled in the work of college grade and 339 in the various short courses.

Commencement.

The annual commencement exercises were held Monday, June 21. Mr. Frank A. Vanderlip of New York gave the commencement address. The graduating class was the largest in the history of the College, this fact being due largely to the return a year ago of so many men whose college course had been interrupted for one or two years by the war. The degree of bachelor of science was conferred on 109 men and 3 women. The faculty decided to award the degree of bachelor of science, honoris causa, to those students who had completed three years' work at the College, and who had subsequently served at least one year in the army or navy. Under this ruling nine men received this honorary degree and diploma.

The Honor System.

One of the most heartening steps taken by our student body in a long while was developed almost entirely through student initiative and leadership last spring in the inauguration of the so-called "honor system" of examinations, by which the instructor leaves the whole question of cheating in examinations to the students themselves. The rules require that each student shall sign a pledge that he has not asked or given help in the test or examination. Cases of broken pledges are handled by a committee of the students, who make their recommendations to the disciplinary officers of the College. The plan is backed by strong public sentiment among the students, and constitutes a real achievement of student leadership. It embodies the best traditions of the institution.

Professional Improvement.

Careful study has been given during the year to a plan for a somewhat new departure with respect to terms of employment of members of the staff of the institution, the chief feature of which is an opportunity for short leaves of absence for professional improvement. Details are now before your committee on course of study and faculty, having been approved by the administrative officers of the College.

Alumni Memorial Building.

By the middle of May, 1920, the full amount of $150,000 necessary for the Alumni Memorial Building had been pledged. This amount was subscribed by 1,150 graduates and former students, and by 750 students and friends of the institution. There were no large individual gifts made, and the percentage of students and alumni contributing relatively small amounts was exceptionally gratifying. Too high praise cannot be given or too great significance attached to the early decision on the part of the alumni to undertake this splendid task, and to the rapidity with which it was completed.

Work on the Memorial Building was started March 30, 1920, and while the progress appears to have been slow, it is probable that the building will be closed in by the first of January, and that it can be completed in time for the dedication at Commencement in 1921. The corner stone was laid at Commencement in 1920, when notable addresses were made by Mr. Atherton Clark of the class of '77, chairman of the building committee, Mr. William Wheeler of the class of '71, and Dr. Joel E. Goldthwait of the class of '85.

The Semi-Centennial.

Plans are rapidly developing for the celebration of the semi-centennial in June, 1921. This will be the fiftieth anniversary of the graduation of the first class. It was decided last spring to carry on a series of events during the year preceding the celebration, largely in the form of conferences on subjects that are just beginning to become of importance, and yet which thus far have not had very much discussion, together with certain special student and alumni features that would have particular bearing upon the idea of the celebration. Rather informally we have been calling this year of special activities our "Year of Jubilee." It began with the laying of the corner stone of the Memorial Building at Commencement in 1920. It was followed in July by a conference of editors of agricultural college publications. In October, at the time of the dedication of the Women's Building, a conference was held on "The Relation of Women to Agriculture and Country Life." In the same month an especially notable conference was held at which the College was host to the American Civic Association, which devoted its entire program of three days to the subject of country planning. On our invitation the American Country Life Association held its annual conference in Springfield, Mass., with one day of its program given at the College; also on our invitation the Land Grant College Association held its annual convention in Springfield, and on the last day of its meeting the entire body of official delegates were guests of the College.

Other conferences have been planned for the rest of the year. Records of these are being kept, and it is hoped that eventually there may be a small volume giving at least a résumé of the main features of what I believe will be regarded some day as a distinct contribution to important developments in the field of agriculture and country life.

World Aggie Night.

In connection with the raising of the alumni fund for the Memorial Building there was held on Oct. 25, 1919, a "World Aggie Night," when there were reunions of M. A. C. men in some 22 cities and towns of the country. The affair was so successful that it was thought advisable to continue the plan another year. The date chosen this autumn was October 29. Records indicate that some 600 M. A. C. men gathered in 40 cities and towns, in 19 States, and also in Cuba, and in the Hawaiian Islands. The College sent representatives to eleven of these meetings in order that the groups might be informed of the work of the institution. For those reunions where it was impracticable to send a representative, information concerning the campus activities was prepared and transmitted by mail. It is hoped that this annual reunion may become a permanent affair.

The Co-operation of Alumni.

The alumni are rallying to the support of the College as never before in its history. The alumni reunion at Commencement last June was not only the largest, but it was by far the most enthusiastic and the best organized since I have been connected with the College. There have been many other evidences of alumni aid, — the magnificent gift of Memorial Hall, the large attendance and great enthusiasm at the World Aggie Night dinners in October, and, more than all, the increasing number of personal and group evidences of interest and pledges of support. We need the backing of the alumni not only in persuading the Legislature to grant adequate financial support, but their counsel with regard to questions of policy and organization must prove to be increasingly helpful.

Legislative Appropriations.

Tables submitted show the main items for annual maintenance appearing in the College budget of a year ago, together with the amounts granted and the amounts used. It will be observed that the total amount granted was $115,000 short of that asked, and the amount used was $4,000 less than the appropriation. The estimate for coal was overrun by $20,000, and the coal on hand Nov. 30, 1920, was 1,000 tons less than that of the same date a year before. The only way by which we prevented a much larger overdraft on our maintenance appropriation was by urging every department to cut its maintenance expenses "to the bone." The work of a number of departments has been seriously handicapped on this account. The appropriations for maintenance have by no means kept pace with the increased cost of labor and supplies, so that the unit expenditure is less than it was several years ago.

In the matter of personal service it will be observed that there is a net surplus of $9,275; in instruction, approximately $10,000; and in the Extension Service, over $5,600. The overdraft in general maintenance of $2,500 was due to the demand for increased wages for laborers which could not have been foreseen.

The Legislature of 1920 was requested to provide funds for a number of pressing building needs at the College, including both a chemistry building and a library. Because of the many other demands made upon the State treasury, both for current expenses and for new construction, it was thought necessary to postpone appropriations for our larger needs. The appropriations granted were $15,000 for the construction of a cavalry barn, and $50,000 for improvements and equipment. (See Table V.)

Analysis of Expenditures.

On the basis of the Treasurer's report, an analysis of the expenditures of the College from State funds for the year ending Nov. 30, 1920, has been made, and the following tabulation indicates the total expenses and the per cent of the whole for the various classifications: —

Classification.	Total Expense.	Per Cent.
Administration,	$54,593 27	7.4
Instruction,	184,051 01	24.9
Short Courses,	35,257 21	4.7
Experiment Station, including M. G. F. S.,	68,321 57	9.2
Extension Service,	84,788 46	11.5

Classification.	Total Expense.	Per Cent.
Heat, light and power,	$96,773 28	13.0
Farm,	61,369 34	8.3
Other producing departments,	81,405 99	11.0
Repairs,	16,898 28	2.5
Trustee, travel and printing,	2,439 66	.3
Control laws,	21,768 81	2.9
General maintenance expense,	32,046 39	4.3
Totals,	$739,713 27	100.0

Improvements and New Construction.

The women's dormitory was completed this autumn. You will recall that the total appropriation was $127,400. This was not sufficient to complete the building and fully equip it. The New England Branch of the Women's Farm and Garden Association came to our assistance and generously gave $2,000 for furniture and furnishings for the living room. The building promises to be satisfactory and convenient. Forty-three girls are now rooming there.

The cavalry barn was completed late in the autumn. It is placed on a site on the Plainville Road a convenient distance from Lincoln Avenue. It was constructed on specifications furnished by the War Department.

Delays in building both of these structures were very annoying, but seemed to be due to very great difficulties contractors have been having in obtaining labor and supplies.

No other substantial improvements were provided, although a large number of minor improvements have been made possible through the appropriations of the last Legislature.

The Departments of Undergraduate Instruction.

The teaching work in the departments of undergraduate instruction has continued during the year along much the same lines as formerly. Consideration has been given by the various divisions to the revision of the course of study for the degree of bachelor of science, in order that the objectives of the work might be more clearly defined and the method of reaching those objectives improved. The requirements for admission to the College have been slightly revised after consultation with representatives of the State Department of Education. The new requirements will be found stated in the current issue of the College catalogue.

More and more demand is being made upon the departments in the Divisions of Agriculture and Horticulture for instruction for the two-year course, and a number of instructors have been added to more adequately carry on this work.

Practically every department in the College has during the year sustained a loss of one or more members of its staff; in many cases the efficiency of the work has been greatly impaired by such changes, and in other cases we have been obliged to omit certain important courses. The damaging effect upon the various departments of these numerous changes in staff cannot be overestimated. If the situation continues, it will not only greatly reduce the effectiveness of our institution, but will virtually cripple our teaching organization.

Another need which has been most pressing for many years, and which is now emphasized by the larger number of students which we have, is the lack of adequate facilities in certain departments in the way of laboratories and classrooms. A library is more than ever a most urgent need, as is also a new chemistry building, gymnasium and armory, and a suitable building for the Departments of Horticultural Manufactures and Pomology. In these and in many other departments the instruction now given is performed under conditions which lessen its effectiveness and make impossible the best economy in operation.

Women's Work.

The completion of the new dormitory for women students marks an epoch in the history of the College. It provides for 98 students, and will furnish an opportunity to develop social life among the girls which has been impossible heretofore. The women students take their meals at Draper Hall, which is located near the dormitory.

We are deeply indebted to the New England Branch of the Women's National Farm and Garden Association for their generous gift in the furnishings for the reception hall, living room and parlors in this dormitory. We are also indebted to this association for scholarships offered to young women interested in the study of agriculture.

A large percentage of our women students avail themselves of the opportunity to elect courses in rural home life. The increasing interest in this work indicates that we must have larger facilities and ample teaching force for further development. We are in need of a practice house where home conditions and home problems may be duplicated as far as possible; also there is need of a gymnasium and some provision for outdoor athletics, such as a basketball court, tennis courts and hockey field.

Work of the Agricultural Counselor for Women.

We find that the number of agricultural positions which are open to women is considerably in excess of the number of women fitted to fill them. This and the good work already being done by those now in the field makes us feel that the College is affording women an opportunity to prepare themselves for important positions in agricultural work. Often women who come to the College have had little or no agricultural experience, and have no clear idea of the opportunities which agriculture offers them, or how to prepare for the work. For these women there is an opportunity to consult with an agricultural counselor for women, both in interviews and in classes.

The Infirmary.

The substantial increase in the number of men students is making constantly more pressing the long-standing problem of infirmary facilities. The presence on our campus of a number of women students brings an additional problem in this connection.

During the year it has been found necessary to employ two resident nurses instead of one, as was formerly the case. Because of the limitations of the present hospital buildings there is still no place where women students can be cared for, unless there are entire wards not utilized by men.

The construction of a first-class hospital with an adequate hospital force cannot long be delayed if we are to be equipped to adequately handle, not only a normal number of cases of sickness occurring in a student body numbering 800 or 900, but also to meet the minimum requirements of the hospital in case of an epidemic. From the statistics furnished by the supervisor of the infirmary, it will be noted for the year just closing that 111 different students were treated at the infirmary as house patients, the aggregate number of days which they were confined being 653. In addition, 636 treatments were given to out-patients.

The Market-Garden Field Station.

The year 1920 has been the most successful year in the history of the Market-Garden Field Station. Official projects have nearly all been carried through, exceptions being in connection with those to be directed by an entomologist. A man has not been available for this work. During the year there have been nearly a thousand visitors at the Market-Garden Field Station, including those who were present at the Field Day, August 4.

The work for the future is fairly definitely outlined, and may be summed up in the following projects: —

1. A study of the best methods of maintaining soil fertility, conducted under the name of the "Manure Economy Test."
2. The study of leading vegetable varieties as adapted to vegetable gardening in Massachusetts, with a comparison of the newer kinds.
3. A seed-production project, designed to determine the cost and value of home seed production, as compared with the use of seed purchased in the open market.
4. The study of green manure crops to determine their adaptability to vegetable gardening conditions.
5. Some special fertilizer studies peculiarly adapted to the vegetable gardening business, and which require demonstration where men can see them under closely controlled conditions.
6. The study of greenhouse lettuce production to determine —
   (*a*) The possibility of improving quality through the discovery of a better variety than that now used.
   (*b*) To experiment with growing conditions under glass to discover, if possible, some better combination than now in use to improve quality.

The greenhouse plant has been completed during 1920, with oil-burning installation. The administration building is sorely needed, and until it is available some types of the work must be more or less neglected.

Increased calls are being made on Professor Tompson for service throughout the State. The amount of correspondence is increasing. The demand at the Field Station is greater from season to season, and it is going to be necessary to have additional men engaged in vegetable gardening work. There has been splendid co-operation from growers throughout the State, and the interest in the work at the Market-Garden Field Station has easily doubled since the Field Day of August 4.

Library.

During the year our inadequate library facilities have been somewhat amplified by the fitting up of the floor above the present library for reading room purposes.

Several thousand books have been transferred to the second floor, and a library assistant provided to care for the needs of students and faculty using this room. It should be emphasized that this adjustment is purely a makeshift, and that it relieves in a very minor degree the necessity for an adequate library building. The librarian reports that the more pressing needs for the library, in addition to a suitable building, are more books and other competent assistants to make available the library facilities.

The library now has 65,000 volumes, more than twice the number catalogued ten years ago.

There is a growing tendency on the part of the teachers and students alike to make use of the library as a common and necessary laboratory, and it is unfortunate that this tendency cannot be more adequately met.

Department of Physical Education.

I wish this report to call especial attention to the organization, work and needs of the Department of Physical Education, for its purpose is far more than management of athletics, important as that is.

The head of the Department of Physical Education is supervisor of athletics. The assistant professor is coach of varsity athletics. There is an instructor in general charge of all two-year athletics, and another of all Freshman athletics. There is also supply man and clerk of the department.

Student voluntary participation in outdoor athletics has greatly increased, especially since supervision by department members has been provided for the major sports. Only one major branch of athletics is without full supervision. This is in track athletics, where the instructor is able to give only the time after 5 o'clock each day for this work. Track athletics should be one of the major sports of the institution, attracting a large number of men who are not active in other sports. Since it is our purpose to get as large a per cent of the student body to participate voluntarily, provision should be made for a man to devote at least his entire afternoon to this work. Hockey may be considered as a minor sport in the institution, but is very desirable, since it is one of the few outdoor sports of the winter season. The immediate coaching and directing of this sport has been in the hands of the senior students, since we have been unable, with the staff employed, to provide other direction and supervision.

It was thought, when Alumni Athletic Field was completed, that adequate space for outdoor athletics had been provided. However, the increase in participation which has taken place since its completion has been so great that during the fall and spring terms it is impossible to provide sufficient space for all the men who wish to participate. Tennis is a minor sport, but attracts a large number of men who are not attracted by other athletic sports. This institution should have at least twelve courts, whereas at the present time we have two very poor ones. Professor Hicks tells me that we should attempt immediately to extend our athletic field equipment to provide for at least twelve tennis courts and two additional football and baseball fields, the same grounds being used for both sports. If the hockey rink, which is at present under construction, works out satisfactorily, it will mean that the College pond can be left open for skating, and that the men who are participating in hockey will have a satisfactory equipment for their work.

This is probably the only educational institution of standing in the country which attempts to maintain a Department of Physical Education without providing a gymnasium wherein the department may follow up the development of men found necessary after the physical examinations. We have maintained a Department of Physical Education for twelve years, and its real function has been the organization and supervision of outdoor games. In the beginning, with the number of students then in College, and with the existing condition of the drill hall, it was possible to carry on some gymnastic work. At present we have not even a satisfactory dressing room for those men who voluntarily take this work. The locker and shower rooms provided are actually unsanitary. To attempt to carry on the work of this department under present conditions is exasperating to all concerned. The greatest need is a new gymnasium building which may be utilized for both gymnasium and military work.

The development of coeducation in the institution has raised the problem of a place for recreation and gymnastic work for the women. For two years they were fairly well taken care of in a temporary gymnasium in the old chapel. However, this was taken away from them when the reading room was installed. Mrs. Hicks has been conducting required exercises for the women throughout each year, but at present the work has been reduced to the absolute minimum because there is no satisfactory place for carrying on the work. For outdoor work they have no field, and it is very discouraging to attempt to do anything for them with the facilities provided.

Department of Military Science and Tactics.

During the year the cavalry unit has replaced the infantry unit of the R. O. T. C. The Legislature of 1920 made an appropriation to provide a stable for the cavalry horses. In October an assignment of 36 horses and 2 mules, together with the necessary equipment, was made. In order to provide adequate care for the horses and instruction to the students the government detailed to the College a commissioned officer and 16 enlisted men. Maj. F. E. Snyder is now assisting Colonel Walker in the instruction work. It is apparent that the cavalry drill is more attractive to the students than the infantry drill, and it is expected that this new feature of military work will fully meet the expectations of Colonel Walker, who did much in obtaining the cavalry unit, and of the War Department.

LEGISLATIVE BUDGET, 1921.

Current Maintenance.

The request for current maintenance for the ensuing year totals $995,000 gross appropriations from the State. This represents an increase of approximately $260,000 over the appropriation granted in 1920. This increase includes the following items: to provide for salary increases, new positions and vacancies allowed during 1920, $40,000; further salary increases proposed for 1921, $20,000; to provide for new positions and vacancies in 1921, $40,000; to meet the increased demands for skilled and unskilled labor, $25,000; travel, office and other expenses, $80,000; heat, light and power, $30,000; repairs, $18,000; control laws, $7,000. A number of new positions are requested for instruction in the Short Courses, Extension Service and Experiment Station.

For Permanent Improvement.

Chemistry Laboratory and Equipment, $600,000. — This is the second time that this structure has been asked for, and it has been under discussion for many years. The Commission on Investigation of Agricultural Education said: "An adequate chemistry laboratory is equally needed. The present chemistry building is one of the oldest, most dilapidated and most unsuitable buildings on the campus." Chemistry is a subject required of every student because it is fundamental in all agricultural work. For the same reason the research work in chemistry demands more space than does any other single branch of investigation. It is estimated that it will require an appropriation of $600,000 to build and equip a building that will be at all adequate to meet the situation. However, not more than one-third of this amount will be needed during the present fiscal year.

Improvements at Power Plant, $76,000. — The appropriation here requested is to provide for an ash storage bin and for two additional boilers and stokers for the power plant.

In order to meet the constantly increasing demand upon the steam boilers, to replace present boilers, some of which are eighteen years old, and to maintain a minimum reserve of boiler capacity for use in case of emergency, our engineer considers it necessary to install two 406-horsepower boilers equipped with stokers. The cost of these items is estimated to be $35,000. A stoker should be installed in connection with a 200-horsepower boiler already used. The necessary cost of setting these boilers, piping, flue work and other necessary repairs and improvements, incident to this installation, amounts to approximately $69,000.

Miscellaneous Improvements and Equipment, $75,000. — This item is composed of some 170 projects submitted by the various departments of the institution indicating department needs for improvements in buildings, for new equipment, for replacement of equipment and for the replacement of live stock. The aggregate cost of these projects would be $133,000. Some of these projects have been deferred for many years, and all should, in justice to the institution, be provided for this year. We feel that $75,000 is the minimum which should be expended this year for this purpose, and a reduction from the total requests by the departments has been authorized by the trustees, only in consideration of the various demands made upon the State treasury by this and other departments of the Commonwealth.

Addition to Rural Engineering Building, $30,000. — An extension to the rural engineering shops is made necessary by the increased enrollment of students desiring instruction in this department. An especially large number of the two-year students are choosing this work, and the present facilities are inadequate. As was expected when the department was organized, it has developed into one of the most useful and popular of the practical departments, and there is really no limit to the service that it can render to the students and the farmers of the State. Farm machinery is becoming more and more an important factor in agriculture. Simply to meet the existing demand requires that the present space be doubled.

Purchase of Brooks Farm, $21,400. — The erection of certain buildings on the campus during the past twenty years has made a serious encroachment on the field plots used by the Experiment Station. Immediately adjoining the College estate on the north is a farm, the soil of which is a continuation of that now used for Experiment Station purposes. The area comprises 60 acres, and farm buildings. In a recent appraisal by three competent judges $21,400 was agreed upon as a fair price for this property. This land is now very urgently needed for the purpose indicated, and, looking into the future, it seems absolutely essential that it be available for experimental purposes.

Tennis Courts and Gymnasium for Women Students, $13,500. — The gymnasium work for women students has been carried on for three years, and the number of women has been constantly increasing. We have been using the old chapel which has been a very satisfactory floor, but as this has now been assigned for the use of the library, it will be no longer available for the girls. The tennis courts should be permanent, and the building a wooden structure with board floor 40 by 60 feet, and 20 feet clearance ceiling, the building to be heated by furnace.

Market-Garden Field Station, $10,000. — In 1919 the State Legislature, through special appropriation, provided $7,500 for the construction of this building. The work has not been undertaken because it was evidently impossible to complete the project with the funds available when it was possible to start the work. Two revisions of plans were made to assist in reducing building costs, but cost of labor and of materials so increased that it seemed unwise to proceed. Consultation with market gardeners of the advisory board, the architect and builder all resulted in advice to wait until adequate provisions could be obtained for the building.

Equipment for Tillson Farm, $10,000. — For a number of years the institution has been developing important research work in connection with poultry husbandry, and it is apparent that valuable results may be obtained by the continuation and expansion of these projects. It is desirable that this experimental work be done at an isolated place. The College owns a farm of about 70 acres located some distance from the main area, and it is proposed to develop this farm as an experimental poultry plant. It will be necessary to build laying houses, a breeding house, an incubator cellar, a feed room and a barn. Considerable fencing must also be done.

The total cost will be slightly in excess of $10,000, but it is thought that this amount will be adequate for the initial work.

Poultry Breeder and Judging Laboratory, $8,000. — During the past two years our poultry plant has been inadequate to meet the needs of the number of students enrolled in the various courses. It is scarcely large enough to take care of our juniors, seniors and Short Course students, while the freshman class, one-year vocational course and two-year course have more than tripled the requirements for laboratory facilities. This laboratory building will house 24 small pens and furnish a large laboratory 20 by 30 for general demonstrations, and a large long laboratory on the second floor to be used particularly for judging and culling.

House for Farm Superintendent, $8,000. — In order to make the most economical arrangement relative to the employment of farm help it is necessary to insure at least reasonable living conditions for them. If the present house occupied by the farm superintendent could be converted into a boarding house for the farm help it would go far in solving the present difficult situation; $8,000 is requested to provide a cottage which the farm superintendent would then occupy.

Macadam Road, $8,000. — There is no first-class macadam road anywhere on the campus. There are two main approaches to the campus which have heavy traffic by sightseers as well as others. The total length of the main drives on the west campus is approximately one mile. All the coal used by the institution is brought in from the railroad stations, chiefly by automobile truck. That portion of the road which is used for this purpose should be macadamized at once. The distance is approximately 1,750 feet, and the estimated cost is $8,000.

THE COLLEGE AT THE CROSS ROADS.

An institution rarely follows a direct road to its objectives. It has its roadside delays, its bypaths, its hills of difficulty. Our College is no exception. In the long look backward we see great progress, but we discover also times of serious discouragement, even hours of crisis. There have been days of criticism, periods of starvation, moments when the very existence of the College was threatened. The College more than once in its history has found itself at the cross roads.

There is no doubt in the minds of those immediately responsible for the administration of the College that it faces another of these crises, perhaps the most significant in several decades. This conviction of a serious situation reveals itself chiefly in a deep feeling of uncertainty — a doubt not so much as to the course the College *should* take, but a real anxiety as to the course it is to be *permitted* to take, and the speed and effectiveness with which it may proceed. I freely grant the fact that uncertainty and anxiety characterize our time. Labor, industry, transportation, commerce, merchandizing, agriculture, religion are nearly rudderless as a result of the great world storm. Doubtless we are facing in America a period of rebuilding in education as in other human interests. The colleges share these large general problems of reconstruction. But the present crisis at the Massachusetts Agricultural College is not wholly a result of the war. It consists in certain pressing questions about policy, program and support that have been gathering force for some time, and now demand answers. The remainder of this report is an attempt to analyze a situation that should not be trifled with.

The Necessity of Increased Salaries.

In my report of a year ago I indicated the outstanding importance of substantial increases in salaries for practically the entire staff. The increases secured by no means met the needs. The failure to pay our employees adequately is still a major problem.

A year ago I reported 39 changes in the staff. The past year there have been 58 changes, — 30 in the professional staff and 28 in the clerical staff. In three important departments the personnel has almost completely changed within the past year. Nearly 100 changes in a staff of approximately

200 persons have occurred in two years. Less than one-third of the Extension staff employed two years ago are now with us. In these two years there have been 43 resignations in the clerical staff which ranges in number from 50 to 60.

I do not wish to be misunderstood with reference to the reasons for nor the significance of these changes in staff. The turnover in all business has recently been unusual. Moreover, commercial business has increasingly been made attractive to men with an agricultural training, as it has been to many other groups of college men. No college can retain all the men it would like to keep. With due allowance for these factors, the situation still remains acute. It takes considerable time for the new employee to begin to do his best work, in the Extension Service particularly. It is estimated that it takes new clerks at least four months to become really effective. Nor will it do to imply that these changes in the clerical staff are of minor consequence — quite the opposite is true. A very small proportion of our clerical service is of a strictly business character; it is almost wholly professional. It needs clerks of good education and of high intelligence. They cannot easily be transferred from one department to another. Each department has its own vocabulary; its own technical procedure. In the majority of the clerical positions the clerk is required to be in some real sense a specialist, so that when a well-trained clerk of this type leaves, the professor for whom she has been working is handicapped in both time and in energy. His main work is seriously interfered with.

Our budget last year called for an increase in salaries for the positions held by the professional staff averaging about 16 per cent. The Legislature granted a sufficient item in the appropriation bill to cover this amount, but the allowances made by the Supervisor gave us an average of only about 12 per cent. These increases at first blush may seem to be reasonably satisfactory. Of the increases recommended by the trustees, those for about one-half the staff were allowed or minor reductions made in them. However, the increases for nearly one-half the staff were materially reduced, individual cuts ranging from $120 to $300, and in some cases considerably more than this. The average cut in the salaries the trustees asked for this group was 34 per cent.

Salaries of Administrative and Professional Staff.

Rank.	Number.	Average Salary, 1914.	Average Salary, 1920.	Per Cent Increase granted, 1920.	Per Cent Increase over 1914.	Proposed Average Salary, 1921.	Normal Average, 1921.[1]	Per Cent Increase requested, 1921.	Per Cent Increase, 1921 over 1914.
Dean and directors,	5	$3,833	$4,580	7.2	19	$4,936	$5,750	7.7	29
Professors: —									
Heads of departments, including heads of divisions,	24	2,625	3,440	14.4	31	3,764	4,200	9.4	43
Not heads of departments,	25	2,175	3,003	12.0	38	3,251	3,500	8.2	49
Assistant professors,	32	1,734	2,358	16.0	36	2,660	2,750	12.8	53
Instructors,	28	1,137	1,696	12.9	49	1,861	–	9.8	64
Total,	114	–	–	–	38	–	–	–	52
President and others on administrative and professional staff.	19	–	$2,997	8.9	–	$3,249	–	8.4	–
Total staff,	133	–	$2,710	12.5	–	$2,972	–	9.7	–

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[1] Salary considered fairly adequate under present conditions.

I am presenting tables which show that the average salaries now being paid in all grades of the professional staff are only 38 per cent greater than were paid in these same grades in 1914, and that, if our estimates for 1921 salaries should be granted, the total percentage of increases in seven years will be only 52 per cent. This is scarcely more than one-half of the increase in the cost of living for the period, for, according to figures prepared by the Commission on Necessaries of Life, the increase in living costs amounts to approximately 100 per cent. We must remember, further, that in a college in which a majority of its staff are relatively young men, an average increase of 5 per cent a year for the entire staff is not excessive, merely in recognition of increased value of service and quite apart from any increase in cost of living. But it will be seen that our staff have suffered *a serious progressive reduction of actual salary income for the past seven years.*

Meantime, the other leading agricultural colleges of the country have met the situation. I submit a table which shows that while average increases in salaries in several agricultural colleges of the country were over 30 per cent from 1918 to 1920, our own were only 15 per cent. These same colleges, with one exception, are proposing further increases, varying all the way from 6 to 35 per cent for next year, while we are proposing an increase of 10 per cent.

Salary Increases in Various Institutions.

	Per Cent Increase made, 1918–20.	Per Cent Increase proposed, 1921.	Per Cent Total, 1918–21.
Kansas State Agricultural College, .	27	30	65
Michigan Agricultural College, . .	60–100	None.	60–100
Iowa State College, ...	20	35	62
University of Wisconsin College of Agriculture.	52	6	60
Ohio State University College of Agriculture.	58 per cent in average salary in various grades.	No further increase in standard salaries.	58
University of Missouri College of Agriculture.	20	38 per cent in maximum salary in various grades.	–
Cornell, College of Agriculture, . .	17–44	11–29	–
University of Illinois College of Agriculture.	33 per cent for lower paid groups.	33 per cent for those not previously increased.	–
Pennsylvania State College, . . .	30	10	43
New Hampshire State College, . .	20	10	32
Connecticut Agricultural College, .	25	Substantial.	–
Massachusetts Agricultural College, .	15	10	26

We have also made an inquiry as to how this institution ranks in the matter of payment to heads of several typical college departments, and we observe not only that we are near or at the bottom of the list in every case, but that the amount of salary in these other institutions in some cases is far higher than ours. In Ohio, for example, the present salaries for department heads range from $3,500 to $6,000. Or, again, in the Michigan Agricultural College the minimum salary for heads of departments is $4,500. We have twenty-seven heads. Three of these serve also as deans or directors, and receive salaries ranging from $3,900 to $4,800; three others are heads of divisions as well as heads of departments, and are receiving salaries of $4,000 or $4,200. Of the twenty-one heads of departments who have no unusual administrative responsibility two are paid $3,900, and the other nineteen receive salaries ranging from $2,340 to $3,720.

Nor is it unfair to compare our salaries with those in some of the liberal arts colleges and endowed universities. In Amherst College the minimum salary for the full professor is $4,500, at least 50 per cent more than our own minimum. Another element in this comparison is the fact that in most colleges members of the teaching faculty have three months in the summer for vacation, for professional improvement, or for further earnings. At present probably more than three-fourths of the members of our professional staff work eleven months in the year.

I reported a year ago that the salaries of our staff had been standardized, with minimum and maximum salaries and definite increments of increase for each grade. It was our supposition that this scheme of grades would be largely automatic. Unfortunately this plan seems not to have been followed in actual operation. It is exceedingly important that members of the staff know about what to expect in the way of increments of salary increases from year to year, so long as their service is satisfactory. In fact, an element in this whole salary situation quite as serious as the failure to actually increase salaries is the uncertainty as to the future.

We can fairly argue for increase of salaries to members of our staff purely on the basis of justice to them. But as a practical business proposition, also, we should make increases. The institutions which have made the most liberal advances in salaries are our active competitors for the type of men that we have on our faculty. There is a scarcity of well-trained men for these positions. Some of us believe that the difficulty of the agricultural problems in New England makes it all the more necessary to have the very best men obtainable to serve as experts in the various departments of the institution. We cannot get them and keep them for any length of time unless we are willing to pay reasonable salaries. Do I need to reiterate that a college consists in its men? Governor Coolidge recently made the statement in public that "it is useless to send boys to college to be educated by an underpaid faculty." Is Massachusetts willing to follow a practice which inevitably will lower the quality of our personnel? Does Massachusetts wish deliberately to plan for a second-grade or a third-grade college in this great sisterhood of land-grant institutions? That issue is with us now.

Administrative Control.

By virtue of chapter 262 of the General Acts of 1918, the College became a State institution in a technical sense, and thus apparently subject to all laws and administrative rules governing the entire group of State departments and institutions. These requirements have been made known to us through a long series of rulings, oral and written, coming from time to time from the State Auditor, the Supervisor of Administration, or the Commissioner of Education.

Some of these rules relate only to details and do not affect the College seriously. Some of them require practice that we think less effective than our former methods. Some of them are in our judgment decidedly detrimental to the best work of the institution. In fact, the whole procedure is becoming increasingly burdensome and unsatisfactory. Let me indicate a few of the main difficulties.

On account of the new regulations the work in the treasurer's office has vastly increased; additional clerks have been taken on wholly on that account. Owing to the necessity of sending all bills to the State House, both payments and statements of accounts are delayed. The monthly statements, formerly in the hands of the administrative officers the middle of the month, now come out two months later, and are practically valueless for current business purposes. I am, indeed, prepared to recommend that some steps be taken to develop an entirely new method of accounting for the benefit of administrative officers, either by allowing them to keep their own accounts, or by a system of budget accounting. The details that must be followed in making purchases cause delay, and it is very doubtful whether better prices are obtained than we could ourselves secure. The requirement that all our printing shall be done by the State printers, as accommodating as those printers are, leaves much to be desired in the way of promptness in publishing material that is of value only as it has quick circulation.

The requirement that all income earned by the institution shall go into the State treasury, instead of as formerly constituting a circulating fund, tends to lower the business efficiency of our producing departments. The fact that we are theoretically supposed to get credit for this income does not dispose of the question at all.

In any college it is necessary to seek men for new positions during the winter or early spring. This past year we were unable to make offers to candidates for new positions or for vacancies until the college year was practically over, and in the case of graduate assistants not until midsummer. In our Extension work particularly we find need to make quick decisions with reference to personnel, but we cannot act on our own decision. We cannot take on any employee, permanent to temporary, nor increase a salary, nor change a grade without permission. Our judgment as to the adjustment of salaries as between different persons may or may not be followed. We cannot even determine our own educational policy; if a choice is necessary between two new positions desired, our opinion concerning the greater need is not final.

Chapter 350 of the General Acts of 1919 states that: "The trustees of the Massachusetts Agricultural College, existing under authority of chapter two hundred and sixty-two of the General Acts of nineteen hundred and eighteen, are hereby placed in and shall hereafter serve in the said department" (Department of Education).

Thus the responsibility for the control of the institution has passed out of the hands of the trustees and the administrative officers chosen by them. The College has come under a government by laws and administrative rulings devised for ordinary administrative departments of government or for institutions of a charitable or penal character — laws and rulings never intended for an educational institution, and certainly not adapted to a college such as this.

Moreover, the question is never asked us, will this new rule make the institution more or less efficient? We are simply required to conform. Standardization of personnel, centralized administrative control, the routine methods of a highly organized bureau are substituted for the judgment of those closest to the work, their full responsibility for results, their specialized experience, and their pride in achievement.

I recognize that we at the College may be prejudiced because some of our old freedom of initiative has been taken away. I have endeavored to discount this. I also want to make it clear that we are not complaining of the attitude or activities of State officials. There is every reason to think that they are simply carrying out the law as they understand it. But I cannot state too strongly a growing conviction that the system as applied to our College is wasteful, unscientific and unworkable.

We do not ask to be released from close financial oversight. We do not wish to be outside of the budget system. We have no desire to break away from the general educational system of the State. We ask that Massachusetts recognize, as other States have recognized, that there is a difference between the College and other State institutions, both with respect to the financial and the administrative control. We ask, also, if it is not possible for this State to give back to the trustees the management of the institution, while at the same time providing all necessary checks upon our activities and methods? Responsibility and initiative on the part of the trustees and other employed officials are absolutely essential to the effective management of the institution.

The Scope of the College.

In my report for the year 1911 I emphasized the proposition that this is an agricultural college and nothing but an agricultural college. The policy of the College for all these years has been in harmony with that declaration. We have stood steadfast against any departure from this fundamental basis of our work. During the past fifteen years the proportion of our graduates going into agricultural pursuits has shown a decided increase over former years.

We have, however, been obliged constantly to broaden our definition of agriculture and to widen the scope of our activities. In my report of 1918 I called attention to the fact that the developments of the war had demonstrated that we must deal with the whole question of the food supply of the people of the State; that it was not enough in our investigations and our teaching and our Extension Service to consider only the production of farm crops and animals; but that we must prepare to deal with questions of food distribution, of food conservation, and even of food use in the home. In this connection may I call attention to the fact that, particularly in our Extension Service, the Federal government is committed to the idea that the land grant college shall develop work in home economics. Yet thus far we have been unable to secure an allotment out of our State appropriation sufficient to give the same support to our county home demonstration work that we are able to give in the case of farm work.

Thus, while the interests and needs of Massachusetts farmers are our first concern, it is also our obligation to place ourselves at the disposal of the entire population of the State, in city and in country, with respect to all these problems of food supply. I am sure I do not need to indicate the obvious significance of this newer definition of our work. It opens up an unworked range of possibilities, and requires us to render an account of our stewardship to all groups of our people alike, — to farmers, to workingmen, to business men, to the entire population of the Commonwealth.

The Administrative Policy and Organization.

Some years ago I presented a somewhat detailed outline of various aspects of policy and organization that I thought should be developed, or at least should be studied. Through the years some progress has been made. It is slow work at best, and the war practically put a stop to any serious study of these questions. We have, however, outlined a plan for securing the co-operation of several groups of persons interested in the College, including faculty, students and alumni, as well as representatives of agencies not immediately connected with the College, in an effort to see if at the forthcoming semi-centennial there may not be presented a clear outline of our problems and how they may be met. I have invited a representative of the United States Bureau of Education, who has consented to work with the Land Grant College Association in these matters, to make a personal study of our administrative organization, and to report his findings and suggestions. We already have on file a report from a first-class efficiency engineer, made after a pretty careful study of the form and method of our business organization. Perhaps the most difficult, and without doubt the most important, of these problems has to do with the course of study; not merely because the course of study must reflect the scope and policy of the institution, but because courses offered, methods of instruction, relationships between vocational, citizenship and cultural aspects of education are all of the utmost consequence in the training of future leaders.

The Permanent Building Program.

For many years I have annually been obliged to stress the fact that we were far behind in our building program. To-day the situation has become not only extremely discouraging but almost disheartening. No major building has been provided in seven years. Departments inadequately housed a dozen years ago are still obliged to put up with the same facilities they had then. New departments have no abiding place. The increased costs of building have only added to our difficulties. You will recall that I laid this whole situation before you last autumn, and, acting under your direction at that time, I have prepared a building program which I believed to be a minimum program for the next ten years. The architect will submit provisional plans for all of these buildings with estimates of cost.

In this connection I mention again the need of a *permanent* building program and financial support for it. Here, too, the element of uncertainty is a prime difficulty. A regular annual apportionment item in the budget, either a fixed sum or a sum the amount of which is designated by a so-called mill tax, or some other method of permanent and regular adequate appropriations for buildings and other permanent needs is another of the crucial needs of the institution.

Public Understanding and Support.

The extent of the service of a State-supported institution is governed very largely by the extent to which the people of the State know the facilities it offers for the education of their children and the solution of their problems. I am amazed from time to time to discover evidences of the slight degree to which the people of the Commonwealth know the College and its work, to say nothing of its possibilities of usefulness to them. It is perhaps not surprising that a Legislature should question a budget so large as ours, unless the people recognize the work the College is doing and capable of doing. I have repeatedly urged larger appropriations for a sane, fair, but aggressive plan of publicity for the work of the College. I am now convinced that this is one of our great needs. Let me make it clear that it is not a matter of advertising for more students, much less a matter of self-praise. It is simply the necessity of laying before our constituents, that is, the people of the entire State, information as to how we are trying to serve them, and of seeking from them counsel as to how we can serve them better. You will remember that last autumn you authorized me to present to you a plan by which the purpose, work and needs of the institution could be more fully laid before the people of the Commonwealth. I have prepared an outline of such a plan.

Will the State support the College?

For thirty years after the College received students it had extremely meager financial support, even for those days. The average annual income from the State for current maintenance from 1867 to 1896 was $13,333, and the average annual appropriation for land, buildings and other equipment for the same period was $12,990. By the close of the century the tide turned. In 1898 the Legislature appropriated $28,000 for the erection of a veterinary laboratory, *the first teaching building of permanent construction erected on the campus,* and since that time substantial modern buildings have from time to time been added. Beginning a few years later, the annual appropriations for current maintenance were progressively increased. The physical "plant" of the institution is now inventoried at nearly $2,000,000. For the fiscal year just closed the total net cost of the College to the State for current maintenance was about $600,000. Our responsibility for the wise use of these large grants is very real; our staff as well as your Board of Trustees are fully conscious of this trust.

However, we must ask the people of the Commonwealth not to blind their eyes to the rapid and wide expansion of effort and the vastly broadened scope of service which has resulted from the use of these large sums. Nor should the State fail to sense the new opportunities which the College continually faces. The main question to be now put, is not the expense of the College to the State, but how far is the State warranted in making appropriations sufficient to permit the College to cultivate these wide untilled fields of opportunity. Theoretically there is scarcely a limit to the service the College can render. Practically, the Commonwealth will set bounds; the College cannot expect to secure all the funds it could wisely use. The real question, therefore, I repeat, is how far the State is willing to go, — how much faith does it have in the results of the investments in the College? We ought to know what support to expect.

I wish it were possible for the Legislature to realize that we are not pressing for added salaries, or for increased maintenance, or for new buildings with any other reason than that in our judgment these appropriations are absolutely essential in order that the College shall render its full service to the sons and daughters of Massachusetts, and, indeed, to the entire population of the Commonwealth. Furthermore, can we not all agree that the institution, if it does its work well, is an investment, an asset not a liability; that it really results in adding to the wealth of the State and not subtracting from it? Is our College to be regarded as a necessary nuisance, or as an object of the most liberal possible support because it is considered indispensable to the economic and social progress of the State?

Can I possibly be more clear or emphatic in stating that this institution is not *our* institution? It does not belong to the trustees nor to the faculty; it belongs to the people of the State. We are their trustees for its effectiveness. We simply report the conditions under which it can be made fully effective. We would be derelict in our duty if we failed to indicate the terms, either financial or administrative, under which we believe it can be made most effective.

In Conclusion.

The College is at the cross roads. These various problems of salaries, of administrative control, of the scope of the institution, of its organization and methods of work, of supplying it with adequate physical equipment, of getting into touch with the people to whom we are responsible, — all of these are elements in a real crisis. I am aware that any institution constantly faces new problems, and that it takes time as well as patience and thought to bring such issues to a satisfactory conclusion. But these questions that I have raised are things that cannot wait for answer if the College is to be fully effective. We are losing ground, gentlemen. We cannot maintain the old *esprit de corps,* the vigorous and aggressive spirit that I think it fairly may be said has characterized our methods and our outlook, if the present uncertainty continues long. I plead, then, for such action on your part and on the part of the Legislature and the State officials as shall enable us, if not to achieve all the ends that we would like to accomplish in the immediate future, at least to have a fuller knowledge of what is to be expected of us and of the extent to which we are to be supported in such service as we are called upon to do.

KENYON L. BUTTERFIELD,
President.

REPORTS OF OTHER ADMINISTRATIVE OFFICERS.

Report of the Dean.

During the year 1919–20 the dean's office was able to try the system of faculty-scholarship advisors with the freshman class in a more intensive way than ever before. This was due to the comparatively small freshman class, which relieved some of our freshman instructors from the usual heavy burden of classroom work. In previous reports I have mentioned the great need of helping the new men to make the transition from high school to college, and the need of a corps of kindly teachers to handle this problem. Professors Machmer and Parker gave a total of time greater than was ever given before by appointed advisors, and I am glad to say their efforts proved most effective. We had a fewer number of men dropped from College and fewer "low" and "below" students on the lterm reports than in any year since I have been in charge he records. This record confirms my belief in the d- ability of giving close personal attention to the first-year dent during the first months of his residence.

In the future I trust we may be able to increase this super- sion. I refer, of course, only to the important months of the first terms. It should not continue, except in a few individual cases, beyond the second term of the freshman year. In order to do this, however, we must either engage one or two special men to give all their time to it, or else employ additional instructors to help relieve the heavy burden of our present staff of freshman teachers.

This report is written at the end of six weeks of the fall term 1920–21, during which time we have not been able to give the freshman the attention we gave him last year. The result, I am sorry to say, is a rather low average of scholarship, and the midterm report is most unsatisfactory. Of course, other factors, like fraternity rushing and other social distractions, have contributed to this unfortunate result. I am quite sure, however, that if our instructors had been able to give as much time and attention as was given last year the story would be quite different.

The question of thorough and continuous work is ever with us, and I do not suppose we can ever hope to solve it entirely. The despair of all teachers is the happy willingness of the pupil to do just a passing grade of work; in view of it the teacher is bound to demand a high grade of work in his own classroom, and to inspire the student by precept and example to do his best at all times. Most of our instructors do make such demands, especially in the first two years. On the other hand, we have our easier courses, and a student often chooses a large program which fails to challenge not only his best effort but any real hard effort at all. The remedy, of course, is mainly in the hands of those who have charge of formulating and welding together the courses of the curriculum.

I have intimated above the deleterious effect upon scholarship of such matters as "fraternity rushing." I feel called upon to say very positively that our system this year (allowing "rushing" to continue for the first two weeks of college) was most disastrous to the scholarship of the two lower classes. The same conditions should not be tolerated a moment another year. Members of each class have freely made personal confession that it was demoralizing and disruptive to a degree they had never experienced before. Since many students and alumni are agreed that a different scheme of fraternity pledging should be substituted, we may hope this year's experience will not have to be repeated.

Last year Professors Machmer and Parker tried to keep a record of the freshmen in respect to previous training and scholarship difficulties. They also collected a great many other data in regard to individual students. I have no doubt that this information proved helpful in more ways than one in the handling of the individual. Of course it takes time and necessitates some clerical help. This year Professor Parker has assumed the work of Professor Sprague who is absent on leave, and Professor Machmer has come into my office as assistant dean. These men, therefore, can only do a small part of the work which they did last year, and the other advisors are too busy to give this important matter any more time and attention than they did last year. I mention this matter simply to emphasize the need of extra help if the advising is to be done with thoroughness.

During the past year the faculty has superseded the old unclassified student arrangement by a new one called "special." It was felt that those who used to enter our "unclassified" group were now well served by the two-year short course, and that therefore we could dispense with it. The faculty, however, realized that there were certain types of experts who might be able to profit by our work who could not be served either by the regular course or by the two-year short course. It was ruled, therefore, that applicants for work in certain departments, whatever their previous technical schooling had been, could appeal to the heads of those departments to be allowed to do special work. If the head of the department is satisfied that the applicant has revealed special skill, or has had a satisfactory practical experience he is to recommend to the president that the applicant be admitted to take such work as may be planned by him either in the short course or the regular course, or in a combination of both. This group is called the special group.

This special student group makes the fourth or fifth distinct group in College at the present time, and the campus presents a larger diversity of groups and grades of students than ever before. This situation presents real problems for those who want to see a harmonious and happy college body. No class of persons in the world is more jealous of prerogative and tradition than the typical four-year student. Some of the men in the other groups, on the other hand, are unable to appreciate this undergraduate point of view. There is therefore a possibility of real friction in the present situation. I am glad to say, however, that thus far we have managed to live together without dissension or misunderstanding. Those who have been in charge of student affairs have handled the dangerous points with extremely good judgment and much wisdom. We are hoping that nothing will happen to spoil the excellent relations of the different groups, and to see them crystallize into a relationship that will continue to promote good feeling and good will.

I should not close this report without a sincere expression of appreciation for the fine service rendered in the dean's office by Prof. Charles H. Patterson during the past two years. As acting dean he was most faithful and efficient in respect to countless details, and most gentlemanly and courteous in his relationships with the students.

Edward M. Lewis,
Dean.

Report of the Director of the Experiment Station.

The greatest present problem before the Experiment Station is that of selection of fields of work. Shall the Experiment Station attempt to cover the whole field of agricultural research, or shall it endeavor to concentrate on a relatively few major problems, and devote all of its energies to their solution? This is a matter of institutional policy, and one which should be thoroughly studied before any radical changes are made in the existing order of things. Especially is it important that all suggestions for new lines of work be scrutinized with reference to their effect on the older lines, and to the possibility of the Experiment Station being able to command sufficient resources to support both classes of activities on a comprehensive basis.

As an aid in this suggested study, I am submitting herewith a statement showing the number of research projects now under way at the Experiment Station, classified primarily in relationship to the food problem of Massachusetts and of New England. It should be understood, however, that the number of projects at hand on a given subject is only a rough indication of the character and importance of the work being done.

Department.	Experiment Station Projects as related to the Food Problem.												Miscellaneous Experiment Station Projects.	Totals by Departments.
	Production.								Conservation.					
	plants.				animals.									
	Nutrition.	Adaptation, Ecology, Physiology.	Culture.	Protection.	Nutrition.	Physiology.	Protection.	Miscellaneous.	Basic Investigations.	Preservation Practice.	Distribution.	Miscellaneous.		
Agricultural economics,	–	–	–	–	–	–	–	–	–	–	4	–	2	6
Agriculture,	12	1	–	–	–	–	–	–	–	–	–	–	–	13
Botany,	1	1	–	6	–	–	–	–	–	–	–	–	4	12
Cranberry station,	–	–	3	3	–	–	–	–	–	–	–	1	–	7
Entomology,	–	–	–	12	–	–	–	–	–	–	–	1	–	13
Horticultural manufactures.	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Horticulture,	–	8	3	1	–	–	–	–	–	–	–	1	–	13
Market-Garden Field Station.	2	2	2	2	–	–	–	–	–	–	–	–	–	8
Meteorology,	–	–	–	–	–	–	–	–	–	–	–	1	–	1
Microbiology,	1	–	–	–	–	–	–	–	10	–	–	–	1	12
Plant and animal chemistry.	3	1	–	2	6	–	–	–	–	–	–	–	–	12
Poultry husbandry,	–	–	–	–	–	2	1	1	–	–	–	–	–	4
Veterinary science,	–	–	–	–	–	–	6	–	–	–	–	–	–	6
Totals,	19	13	8	26	6	2	7	1	10	1	4	4	7	108

It will be noted that the mass of our station activities represent studies of problems of production. To a much lesser degree, and only recently, have problems of conservation and preservation been given attention in a thoroughgoing and comprehensive way. Even less attention has been given to problems of distribution and marketing, at date of writing six only out of one hundred, eight projects being devoted to this branch of agricultural research. Finally, the human or social problems of the countryside are receiving no attention.

Even if it be granted that all work actually under way is adequately covering the field indicated, it is still evident that the Experiment Station is at present unable to cover adequately the whole field of agricultural research. This fact becomes even more evident when the status of work actually under way is investigated. On account of shortage of land, the Department of Agriculture has given up several important lines of work, and in other ways curtailed its activities. For the same reason investigations on tobacco soil sickness as carried on by the Department of Botany have been so severely handicapped as to seriously reduce their efficiency. On account of shortage in personnel, the Department of Entomology has been unable to follow up several lines of work started by Mr. Vinal and incomplete at the time of his death. Similarly the Department of Botany has been unable to give full service in the investigation of certain fruit diseases, even though the fruit growers of the State have been insistent in their demands for this class of work. These serve but as illustrations, but they indicate the necessity for most careful study of the whole body of station activities. This problem is now being studied by a committee from the Experiment Station staff, and report will be made in due course.

THE NEED OF ADDITIONAL LAND.

Apart from the question of institutional policy regarding the initiation of new lines of work, there is, as indicated above, immediate need for more land to be available for experimental purposes. It is certainly an anomaly that an agricultural experiment station should be handicapped by a shortage of land. Such, however, is the fact. The encroachment of buildings is primarily responsible for this state of affairs. Draper Hall, Flint Laboratory, the Poultry Plant, Stockbridge Hall, the Rural Engineering Shops, and, more lately the Abigail Adams House, — all these have contributed towards diminishing the area of land available for Experiment Station uses, and likewise through unavoidable trespass decreasing the value of land remaining. I feel that under the conditions the Experiment Station has given a wonderfully good account of itself, but there is grave danger that unless these conditions can be remedied the work will more and more be carried on in an impractical way and on a laboratory basis. It will be lacking in the vitality which comes from close touch with the problems of the land, and to this extent will be unable to render full service to the farmers of the State. Therefore I must urge that this matter be given prompt consideration.

ADDITIONS TO THE EXPERIMENT STATION STAFF.

In order that the Experiment Station may better carry on existing lines of work there is need of additional assistants in a number of departments. Assistant research professors are needed in the Departments of Botany, Horticultural Manufactures, Pomology and Microbiology. In each of these departments the mass of work which has developed, largely through the greater understanding on the part of the people of the State of the service rendered by the Experiment Station, makes such additional assistants imperative. Other assistants are needed in the administration office, at the Market-Garden Field Station, and in the Department of Veterinary Science; while additional graduate assistants can be used to splendid advantage in the Departments of Agricultural Economics, Pomology and Microbiology.

All of the above are needed to give full service on accepted projects now carried on our lists. Other positions which should be considered in the near future, but which contemplate increasing the scope of station activities, are those of research professor of farm management, and research professor of rural sociology, respectively, in the Departments of Farm Management and Rural Sociology.

PROJECT ORGANIZATION.

Within the past year a definite attempt has been made to place all of the Experiment Station work on a definitely outlined project basis. This change was instituted by Prof. F. W. Morse, formerly acting director, and much progress was made previous to my undertaking the responsibilities of the director's office. With this work nearing completion it becomes apparent that a thoroughgoing study and reclassification should be made of existing Experiment Station projects, and that in the future all new projects should be so outlined as to secure the co-operation of all departments concerned. In order that this may be done, committees have been appointed from the different departments in the Experiment Station to give this matter attention, and to report back to the station staff in the very near future. It is hoped that this procedure will result in a better organization of our research forces.

THE CONTROL SERVICE.

The work of the chemical control service has been carried along the same efficient lines as in past years. To the labor involved in the annual fertilizer and feed inspection, and in the inspection of dairy glassware and apparatus, has been added that of the enforcement of the poultry disease elimination law. It is too early yet to make full report as to the results, but the demand for this service, evident at the beginning of the second year, indicates that it should be continued, if possible, on a more thoroughgoing basis than during the past season.

ACKNOWLEDGMENT.

In conclusion I wish to acknowledge the hearty and loyal co-operation accorded me by the different members of the Experiment Station staff. I believe that the time which is usually lost in changing any administrative organization will be somewhat decreased through the services thus freely given. Particularly I wish to express my appreciation of the co-operation given me by Dr. William P. Brooks, formerly director of the station and now consulting agriculturist; Prof. F. W. Morse, formerly acting director; and Dr. J. B. Lindsey, vice-director of the station. All of these men have spared no pains in placing at my disposal all information needed in prosecuting the work.

SIDNEY B. HASKELL,
Director.

Report of the Director of the Extension Service.

The most outstanding fact in the Extension Service during the year 1920 has been the number of resignations. At the beginning of the fiscal year six vacancies existed in the professional staff. But two of these vacancies are filled at the present writing. Since Dec. 1, 1919, the following have resigned: Laura Gifford, assistant State leader of home demonstration agents; John D. Zink, supervisor of exhibits and Extension schools; Delos L. James, Extension specialist in dairying; L. Wayne Arny, Extension editor; Roy B. Cooley, Extension specialist in animal husbandry; Henry E. Haslett, Extension specialist in sheep husbandry; Earl Jones, Extension specialist in soils and crops; and Helen M. Norris, assistant State leader of Junior Extension. During the year 33 clerks have been hired in order to keep 11 positions filled, and at present there are two vacancies. But two of the present staff of clerks were on the pay roll a year ago. Further evidence of the inability to fill positions at the salaries allowed may be found in the unexpended balance of $5,600 in the salary account.

The one principal reason for this crippling overturn in personnel is the inability to pay as much for equal grade of work as is being paid by institutions of similar type in other States, and by private business. Connecticut, New York, Ohio and Indiana have outbid Massachusetts by several hundred dollars for each type of work. The average salary gain to those specialists who left the service during the year was in the neighborhood of $900 each. Others have stayed at a fearful sacrifice through loyalty to the responsibilities that they have assumed, and a hope that a fair measure of justice will be done them in subsequent salary readjustments. The statistics of overturn in clerical staff are the only necessary comment on our inability to hold adequate clerical help at the prices which we have been paying. When it is remembered that it takes a well-qualified Extension man a year to make his contacts and pick up the threads of work throughout the State, the loss in continuity of work accomplished, and in the money cost to the State of training a new staff of specialists, may be appreciated. The same is true in a fair degree of the clerical staff; much technical matter is included in the work of every day, and it is of great importance that the clerk who assists each specialist be familiar with both subject-matter and personnel throughout the State with which the specialist deals. During the past year a staggering total of time and effort have been required by new specialists in starting work, and by all specialists in training clerks who have afterward left for more lucrative work. While a number of changes have come in the county staffs, the vacancies have been filled quickly, as the Trustees for County Aid to Agriculture have been able to offer salaries sufficient to attract capable men and women.

The demonstration project work of the Extension forces has been remarkably well maintained in view of the foregoing handicaps. A fair continuity in the county staffs and increasing numbers of farmers co-operating in the demonstrations made this possible.

The best practices in agriculture and home-making, which it is the task of the Extension forces to promote, are already being followed by individuals. Those farmers and home-makers who are successfully following them are the best teachers of others. It is on this basis that Extension work is growing. The specialist and county agent strengthen the practice of the co-operating demonstrator; if necessary, train the demonstrator to tell how he or she does the work; and organize the attention of the community to the demonstration. In this manner the demonstrator and the demonstration are always available, and the agent and specialist have reached scores instead of individuals. These continuing demonstrations also do much to bridge the gaps in work caused by vacancies on the staff, as good farmers who have once accepted good practice usually continue to follow it, and to spread the teaching. Few changes in project activities have been made during the year, and a separate detailed report will be made on each of these as soon as the statistics of the county work are complete.

Casual work presents a serious problem. Many inquiries are received daily from individuals, and these are given personal attention, not only by Extension specialists, but also, if necessary, by the resident teaching faculty. Such work must always be done. We also have met most of the calls for casual lectures, and have been able to relate a larger number than ever before to demonstration work. The lecture that is not so related is usually unproductive of any permanent good. The people who ask such lecture service are quite ready to see the value of continuing demonstration work, and by relating such effort to the county agent projects much gain has been made in comparison with former years.

To assist in meeting individual inquiries, and to aid in all

Extension teaching, the staff has worked out a plan for a basic literature of Extension work, and is also revising and bringing up to date the various correspondence courses. With these new aids we are in better position to meet the demands of the hundreds of thousands of suburbanites and village dwellers who have good right to expect of the College assistance in their matters of horticulture, food preservation, poultry keeping and home-making.

Relations with both the United States Department of Agriculture and county agents have been most cordial. The constructive suggestions of both have been the basis of some changes in policy and procedure. On the other hand, we find a great readiness on the part of the county staff to accept suggestions on subject-matter and on methods of demonstration.

Looking forward to the new year our principal need is for men and women of experience and capacity who can take up the work interrupted by resignations, and who can be sufficiently supported to enable their continuance with us for more than a brief time.

JOHN D. WILLARD,
Director.

Report of the Director of the Graduate School.

The time has arrived when it is desirable to present as briefly as possible a comprehensive yet concise survey of the Graduate School, that its purposes, its articulation with the College, its methods and its functions may be understood.

PURPOSES OF THE GRADUATE SCHOOL.

Agriculture is so big, so vast, that its values and its significance are unappreciated and even lost to the ignorant mind which does not know what it is; to the restricted mind, even though operating within the field of agriculture, which lives upon itself and within its own encasement; and to the keen and broad minds engaged in other provinces of thought. Its practical, scientific, commercial and social bearings are so intimately bound up with the physical welfare, therefore, the mental and social welfare, of every individual and nation, that to neglect any part of its study and development means disaster to society. It is one of the essential elements without which no nation can succeed or grow.

There is reason for this peculiar situation regarding agriculture. The man who raises a good crop of corn in accordance with recognized practices thinks he knows agriculture; the man who handles the products on the markets will tell all about agriculture; the man who studies the underlying problems of soils and plants will set forth the facts of agriculture; and even the man who sits on the fence smoking his pipe, while the weeds grow, is a typical *exposé* of agricultural practices. Surprising, but it seems true, the one type condemns the other as theoretical, impracticable, unnecessary. In a way agriculture is familiar to everybody, yet it is probably the least understood vocation. Perhaps no field of activity lacks so conspicuously in unity to build up a profession, a task, and to circumscribe its content. Is it not lamentable that any one engaged in agricultural pursuits should minimize any other aspect of agriculture that he may foster his own and antagonize the general good of agriculture as a whole? He exploits only his own ignorance of the profession of which he is a part; he dishonors and degrades the most noble vocation given of God.

To understand agriculture in more specific terms, to comprehend the underlying principles of agriculture which serve as a directive and imperceptible guide, to grasp the operations of agriculture in its relations with commerce and the feeding of populations of the world, lead immediately to the most profound depths of learning and research, to the most skillful devices of man, and to the great multiplicity of human exchanges and events. Agriculture is like the background of a large painting holding complacently in its lap, as if fondling them, humans playing as many sustained parts of a drama as there are individuals.

An extensive western farmer makes a practice of sending his sons to engineering schools for their training, although he expects them home to resume farming. He avoids agricultural colleges. He has learned the value of the intensive training of the engineer, and has recognized the importance of mechanical devices on the farm. By so doing he has recognized, however, only a single aspect of farming, although he understands the values of intensive education, and appreciates only a few values of agriculture. His ideas should be, more completely, engineering not only in mechanical devices, but in physics, chemistry, microbiology, botany, zoölogy, entomology, plant and animal diseases, plant and animal breeding, soil fertility, crop production, animal production, administration, business and social contacts. Such engineering courses are essential in the understanding and interpretation of agriculture, while the western farmer's attack is a single-track approach to it. This is not saying too much for agriculture, for how can soil be intelligently interpreted without a knowledge of the physics, chemistry and microbiology underlying its nature; how can crops be fully comprehended without a knowledge of the botanical laws of plant life; how can animals be known in health and disease without a knowledge of anatomy, physiology and the causes of disease; how can breeding proceed sanely without a knowledge of the genetic laws governing plants and animal life; how can man proceed to preserve food unless he knows the habits of those organisms which cause spoilage and poisoning; how can a man understand business in a wholesome manner unless he knows something about the principles of banking, transportation and other economic problems? These are only a few suggestive reflections in the vast field of agriculture. This answer may be made to the above questions: There are apparently quite successful farmers who would not qualify under these terms. This is allowed. As in every walk of life there exist "recipe" farmers as there exist "recipe" medical men, and they are needed, but this type never contributes to progress, although they sometimes produce sensational kaleidoscopic pictures within their own very restricted boundaries. Men may gain this training by individual study and experience. Such men are the strongest for such development, but, too, such men are very, very rare. Agriculture is suffering intensely from a lack of well-trained, understanding and sympathetic men, — men who are basicly and fundamentally trained, so well trained, in short, that they will be able to build out of the elemental material, rendered available from time to time, new practices, new growth, and, in fact, progressive fundamental development in agriculture. Is a man a banker because he can buy a draft; a man a carpenter because he can shingle a roof; a man a merchant because he can sell carpetsweepers; and finally, is a man a farmer because he can grow a crop of corn? The greatest hindrance to professional agriculture at the present time is too frequently the antagonism offered by men who are actually engaged in agriculture, who occupy a very limited niche in agriculture, and who have only a very narrowed and restricted vision when regarding it; in other words, practical men of agriculture think only of formulated action without regard to agricultural development. Agriculture to such men is mere mechanical business.

No single human can master the entire field of agriculture. He should be in sympathy with every phase, and should have a general knowledge of every aspect to found his sympathy upon. *Intense specialization, therefore, after securing a general basic training,* is almost essential for successful pursuit in any growing agricultural undertaking. *Here is where the Graduate School functions:* After proper basic and general training has been obtained, in undergraduate study, it takes the student for intensive, comprehensive, effective and sympathetic training in the various special or prescribed fields of agriculture.

It follows that the Graduate School gives emphasis to a study in the —

1. Practices employed in agriculture as found in the Departments of Agronomy, Animal Husbandry, Dairying, Horticultural Manufactures, Landscape Architecture, Pomology, Poultry Husbandry, Vegetable Gardening.

2. Sciences underlying these practices as found in the Departments of Botany, Chemistry, Entomology, Mathematics, Microbiology, Physics, Veterinary Science, Zoölogy.

3. Economic phases of agriculture or business relations as found in the Departments of Agricultural Economics and Farm Management.

4. Social aspects of agriculture and rural life as found in the Departments of Agricultural Education and Rural Sociology.

THE ARTICULATION OF UNDERGRADUATE AND GRADUATE WORK.

College undergraduate work should deal with such preparation as will enable a man to begin to pursue intimately, fundamentally, successfully, and without too great restriction, any special and selected line of study or practice related to agriculture in its relations to itself, to other subjects and to society. At the same time, it should equip him to appreciate intelligently his complete environment for purposes of social evolution, social contacts and usefulness in the world.

Graduate study and training lead to a more intensive, more specific and more masterful usefulness in definite fields; also to more exact and effective thinking, to greater initial values and to greater efficiency. While it is a continuation of undergraduate work with changed attitudes, methods and purposes, it brings to consciousness broader provinces of knowledge, a keener power of analysis and synthesis, and a greater capacity for creative and safe performance.

REQUIREMENTS OF A GRADUATE SCHOOL.

1. First-class men for research and instruction, who have had or should have proper training, and should appreciate graduate study and its significance of values.
2. Equipment enabling men and students to pursue their studies and carry on research work unhampered.

Both of the above are to be found or should be found for undergraduate and Experiment Station efforts.

THE APPRENTICESHIP SYSTEM.

In attempting to carry out the graduate study in this institution the apprenticeship system has been adopted. This consists in associating with each graduate instructor from one to three graduate assistants, who not only aid the instructor, but are brought into a more intimate contact with his special or major field of activity. While so closely associated with their major studies, these assistants or apprentices have the privilege of gaining such supporting work and broader interpretations as may be available in other departments of this institution, or wherever such is to be found in other institutions, in its strongest form. By this scheme the cost to the institution is materially reduced as well or rendered nil. The system has worked so well that its value has not only been demonstrated to the institution, but it has enabled instructors to estimate the value of students thus employed much more accurately, and has contributed much to the training of students themselves.

The Spirit of a Graduate School.

A controlling spirit directs the destiny of purposes, likewise a controlling spirit pervades the atmosphere of a graduate school. It is not always easy to detect or define what form the spirit takes. That it makes for betterment in agriculture is patent, whether it is a spirit which favors practice, research, education or social conditions. As it reveals itself, it seeks in practice to widen the horizon, embodying a familiarity with the methods employed in various sections of the country; to deepen the knowledge of detail, circumstances, location, and all the known factors controlling or influencing; to understand the bearing of research and its application to practice; to relate practice to commerce and to amalgamate all elements involved into a useful country life of elevating character; it seeks in research to find those principles or laws which make working policies possible, and those facts which will serve agriculture as the fertile elements of the soil serve the plant (while these facts make it possible for "recipe" farmers to work their farms, they also furnish the material out of which the professional type of farmer creates new practices and new successes or improvement); it seeks in education to acquaint the individual with such knowledge as will make him a more effective agent, and give mental discipline for purposes of mental vigor and accuracy; it seeks to remind man that he is a social agent, a member of society, and has a social relation. Such is assumed to be a skeleton outline of the spirit, and, in short, it is the uplift-material of the individual in his social contacts and environments and his work as he is found in the country, but it is not the spirit which stimulates and produces. It is the channel through which the spirit struggles for results.

Underneath all of this should be a real constructive spirit-agent manifesting itself through enthusiasm in work and devotion to agriculture by a craving to find new truths and new facts which will aid; by an eagerness to disseminate such truths and facts as have been found useful and may become advantageous; by a keenness of purpose to establish practices upon a basis of proved evidence and not haphazard and careless observation. Such a spirit should take absolute possession of the energies of the individual, and should be productive to the greatest good; it should be as unhampered as possible, as free as is conformable with liberty; it should not be burdened and curbed by the friction of the stupendous burden of multiple organizing mechanisms or agents; it should possess an unharrowed existence, otherwise it will die. Its death is the death of progress.

Occupation of Graduate Students.

Fully as large a percentage enter some phase of agricultural work as is the case with the undergraduate students.

Some idea of the outlets for graduate students may be gained by the following concise suggestive statements from several of the departments doing graduate work.

Department of Agricultural Education. — Highly trained men are needed in the field of education, as teachers in the high schools and colleges; Extension teachers; supervisors and directors of agricultural and other vocational teaching; training teachers of agriculture; superintendents of rural schools; directors of the county Y. M. C. A. work, Boy Scouts and agricultural clubs; and as agricultural missionaries and trainers of rural teachers in the field of missions.

Department of Agronomy. — Men highly trained in the study of soil fertility and field crops are needed as teachers, research workers and specialists in our agricultural colleges, experiment stations and United States Department of Agriculture. In commercial work they are needed for research and in an advisory capacity. Such work includes soil survey, study of fertilizer resources, problems in the nutrition of plants, plant breeding, etc.

Department of Botany. — In botany there are large opportunities in several branches of the science. Teachers in general botany, mycology, pathology and physiology are in demand by agricultural colleges. Well-trained specialists for research, especially in pathology and physiology, are always needed by the experiment stations and the United States Department of Agriculture, and the supply never equals the demand. The call for trained botanists comes not alone from the institutions devoted to agriculture, for the science is taught in practically all colleges and universities. There are frequent opportunities to place men in both teaching and research positions, many of which are very desirable.

Department of Chemistry. — In chemistry, particularly in its relation to agriculture, the demand for well-trained chemists at the present time exceeds the supply. Men who specialize in chemistry in the undergraduate course are fitted for positions in agricultural industries, — fertilizer, feed and insecticide manufacture, — as well as in other lines of industry, and in the State experiment stations and commercial laboratories. Men are encouraged, by the aid of graduate assistantships, to take postgraduate courses and fit themselves for advanced positions in industry, as well as for teachers and research workers in our colleges and experiment stations. Well-trained men with ambition and earnestness of purpose are reasonably sure to secure satisfactory positions.

Department of Entomology. — Thoroughly trained men are needed in entomology, as Experiment Station entomologists and their assistants, in the same line of work; scientific assistants connected with the United States Bureau of Entomology, working on injurious insects in all parts of the country; entomologists connected with county farm bureaus, to advise, direct and supervise control work; Extension entomologists connected with the different agricultural colleges; teachers of entomology in agricultural high schools, other schools and in colleges; and as business men who contract for work as caretakers of trees, shrubs, etc., on estates, in cities and towns and elsewhere, protecting them from insect depredations and the attacks of disease, pruning, filling cavities, spraying and in other ways preserving them in good condition.

Department of Landscape Gardening. — There are unlimited opportunities for men of broad education and thorough technical training in landscape gardening, as, for example: in professional practice; in the employ of established architects, engineers, architects and town planners, State and municipal or private parks; as recreation engineers in parks and forests, in institutional planning and superintendence, in teaching and Extension work, with nursery firms and construction contractors, etc.

Department of Microbiology. — Microbiologists are needed in practical and research dairying, in soil biological studies, in food drying, refrigerating, canning, brining, fermenting and preserving; in food decomposition, poisoning and sanitation; in fermentations, as vinegar and industrial processes; in public health problems, as water supplies, sewage disposal, food supplies; in communicable diseases of men, plants and animals. Each of the latter in agriculture falls in specialized departments.

Department of Poultry Husbandry. — Highly trained men are needed in the field of poultry husbandry as investigators in the refrigeration of poultry; candling, packing and transportation of poultry and eggs; preparation of poultry for market (fattening); the study of the inheritance of various characters and functions; management; general sanitary methods and pathology; incubation, brooding and growth; also instructional work.

CHARLES E. MARSHALL,
Director.

Report of the Director of Short Courses.

The demand for Short Course work in this College, as may be seen from the following table, has steadily increased: —

	1918	1919	1920
The Two-Year Course,	37	238	277
The Ten Weeks' Winter School,	91	63	112
The Summer School,	68	238	322[1]
The Vocational Poultry Course,	5	13	19

[1] Four and eight weeks.

The substantial financial support granted by the Legislature of the Commonwealth for Short Course work has enabled the College to meet this growing demand. The increased enrollment and the development of courses have given rise to problems that should have immediate consideration. These may be summarized as follows: —

1. The organization of intensive vocational lines of work in the second year of the Two-Year Course.
2. Provision for housing the student body.
3. The development of a separate Short Course staff.
4. A modification of the Ten Weeks' Winter School so that it will more fully serve the people of the Commonwealth.
5. The organization of social science courses in the Summer School.

The Organization of Intensive Vocational Courses. — The course of study for the Two-Year Course as now arranged provides for certain required courses during the first year, with a few electives. During the second year there are but few required courses, and the work is chiefly elective, as will be seen from the course of study included in this report. The present organization of the course fails to meet the real needs of the students. The interests of these students are very specialized. They wish to devote practically all of their time to one or two subjects. They object, and I share their objection, to being compelled to carry courses in which they are not interested merely to fill out the program. Students ask, for example, not for five hours a week of poultry or fruit growing, but ten or fifteen hours a week. I would respectfully suggest that we endeavor to reorganize the work of the second year, giving much more time to each of the subjects, and then permitting the students to carry but two major subjects with one required general course in addition; that is, a student might carry in one term, farm management, dairying, animal husbandry. I urge this modification for two reasons: (1) the men will be far better prepared for their life work; and (2) it will more clearly differentiate the four-year and the two-year work. The Two-Year Course is a vocational course and should be made such.

The following table, showing that 57 per cent of the students enrolled in the Two-Year Course are twenty-one years of age or over, is included to point out the fact that this student body is relatively mature, and that the mind of the individual student is pretty well fixed on a certain goal before he comes to College: —

Age (Years).	Number.	Per Cent.
17,	19	6.7
18,	33	11.3
19,	34	12
20,	36	13
21,	26	9
22,	24	8
23,	19	7
24,	14	5
25 and over,	75	28
Totals,	280	100

Provision for Housing the Student Body. — It will be noted that the attendance for the Winter School is small. Under present housing conditions it has to be kept small. The opportunities for service to the State are limited by the fact that Amherst does not provide sufficient housing accommodations. I wish to urge just as emphatically as possible the need for dormitories that will accommodate a portion of the student body. It is immaterial to my mind whether the dormitories be built for four-year men or for two-year men. The building of a dormitory will release a certain number of rooms that may be used for student accommodations, thus making it possible for us to house the students that come to the College.

The Development of a Short Course Staff. — Thus far no special Short Course staff has been organized for the instruction of the Short Course men, although a number of the general College staff are paid from Short Course funds. It seems to me the time has come when we should begin to develop a Short Course staff made up of men particularly fitted for this type of teaching. Such a staff would bear the same relation to the general staff that the Extension Service men now bear to the departments. There are two great advantages to this plan: (1) it creates a body of men who are especially interested in the success of the Short Course students; and (2) it promotes good feeling between the four-year and the two-year men, in that neither will feel that the other has an advantage.

A Modification of the Ten Weeks' Winter School. — I wish to suggest a very radical change in the organization of the Ten Weeks' Winter School. All of the courses with one exception now offered in the Ten Weeks' Winter School run ten weeks, and the student has to take a general diversified program. There is one exception to this — there is the dairy school which is practically a separate school in itself. My suggestion is that there be organized a series of schools that would last, two, four, six, eight or ten weeks, and that all these schools come under the title of eight or ten weeks' winter schools. I think eight is preferable to ten, in that the students now enrolled in the Winter School of Ten Weeks are very anxious to leave during the last week or two to begin work.

The Organization of Social Science Courses in the Summer School. — The College should take through its Short Course work a more definite step toward the organization of social science courses in the Summer School. There is a demand — a demand that we have never met — for the preparation of men and women for social service. I suggest that we should begin this next year in the Summer School the development of courses that will fit men and women of maturity and rural experience for work in this field.

The Federal Board for Vocational Education. — The Federal Board for Vocational Education has selected this College as one of the training centers for the men disabled in military and naval service of the United States. These men vary in academic preparation from College graduates to men who have not completed the common schools. They range in age from eighteen to fifty years. The majority of them are enrolled in the Two-Year Course. The need of these men for education that will fit them for life is very great. The experience for the past two years has shown that the adjustment the men had to make from war to peace was far greater than the adjustment from peace to war. Approximately 50 Federal students will complete the Two-Year Course in March of this year. In order to make provision for the men who had no previous education, or whose previous education was very limited, special unit courses were organized in co-operation with the Federal Board for Vocational Education. In these courses men were taught to read, write and speak the English language, besides being given instruction, at the same time, in agricultural and horticultural subjects. It is interesting to note that many of these men who practically had to be taught to read and write will be able, within the next six months, to enter the Two-Year Course. Approximately 300 Federal students have been enrolled in Short Courses since June, 1919.

The Summer School for 1920 was managed co-operatively by the Massachusetts Agricultural College and the Division of Elementary and Normal Schools of the State Department of Education. The College offered subjects in agriculture, horticulture and related subjects. The State Department of Education provided courses in elementary education for teachers. The arrangement was even more popular than for the summer of 1919. Many expressions of appreciation of the plan were offered by the students. By special arrangement courses were provided for the Federal students. I suggest that the plan of co-operation between the two agencies be continued for another summer.

Supervision of Farm Practice. — The need of supervision of the students in the Two-Year Course, during the six months that they are required to work on a farm, was met by the appointment of Mr. Willard K. French as assistant professor of farm management. Mr. French has undertaken the work with a good deal of enthusiasm and energy. I feel sure that under his direction the six months spent on a farm by our two-year students will be of very great value to the whole course. Mr. French's duties include, also, assisting the men to find positions on completion of their course.

JOHN PHELAN,
Director.

TABLES AND STATISTICS.

TABLE I. — *Resignations.*

Position.	Name.
Supervisor of Correspondence Courses and Extension editor,	L. Wayne Arny.
Stenographer, Department of Rural Home Life,	Nellie V. Barkhouse.
Private secretary, president's office,	Evelyn Brewster.
Clerk, treasurer's office,	Ruth Brooks.
Instructor in physics,	Henry J. Burt.
Assistant chemist, Experiment Station,	Arthur M. Clarke.
Professor of forestry,	William D. Clark.
Clerk, treasurer's office,	Grace M. Colburn.
Extension assistant professor of animal husbandry,	Roy B. Cooley.
Assistant professor of agronomy,	Herbert P. Cooper.
Cataloguer at library,	Lalia M. Damon.
Instructor in poultry husbandry,	A. Lawrence Dean.
Library assistant,	Louise J. Delano.
Assistant, Department of Physical Education,	Llewelyn L. Derby.
Clerk, Department of Microbiology,	Marion F. Dondale.
Clerk, Extension Service,	Hazel E. Donovan.
Clerk, power plant,	Noellia C. Duval.
Stenographer, treasurer's office,	Charlotte E. Erickson.
Library assistant,	Lottie M. Fosdick.
Stenographer, registrar's office,	Margaret Gaskill.
Assistant leader, rural home economic projects,	Laura R. Gifford.
Clerk, Extension Service,	Lillian S. Hadfield.
Clerk, Department of Agricultural Economics,	Laura W. Hager.
Stenographer, Extension Service,	Catherine A. Harrington.
Extension specialist in sheep husbandry,	Henry E. Haslett.
Clerk, Extension Service,	Marion Hawthorne.
Instructor in microbiology,	Edgerton G. Hood.
Instructor in animal husbandry,	Richard L. Holden.
Assistant in veterinary science,	T. George Hull.
Assistant in physical education,	Brooks F. Jakeman.
Extension specialist in dairying,	Delos L. James.
Extension associate professor of agronomy,	Earl Jones.
Assistant physical education,	Arthur M. McCarthy.

TABLE I. — *Resignations* — Concluded.

POSITION.	Name.
Professor of animal husbandry,	John C. McNutt.
Instructor in agronomy,	Frederick G. Merkle.
Extension professor of community planning,	Ezra L. Morgan.
Associate professor of language and literature,	Robert W. Neal.
Extension instructor in agricultural education,	Helen M. Norris.[1]
Resident nurse,	Elizabeth Olmstead.
Clerk, president's office,	Rachel C. Packard.
Clerk, Extension Service,	Helen L. Phillips.
Clerk, Department of Dairying,	Frances Powers.
Chief clerk, Extension Service,	Jessie M. Prince.
Clerk, president's office,	Marjorie T. Silcox.
Field agent,	Almon W. Spaulding.
Instructor in farm management,	Leland Spencer.
Clerk, treasurer's office,	Miriam Spencer.
Stenographer, Extension Service,	Marjorie E. Sullivan.
Stenographer, Extension Service,	Aline B. Suprenant.
Stenographer, Extension Service,	Clara A. Swift.
Associate professor of physics,	Harry C. Thompson.
Instructor in dairying,	Stanley E. VanHorn.
Clerk, Division of Agriculture,	Marion L. Warner.
Instructor and foreman in vegetable gardening,	Gilbert S. Watts.
Stenographer, Department of Botany,	Ellen L. Welch.
Instructor in dairying,	Fred E. Wheeler.
Stenographer, Extension Service,	Mrs. Ruth S. Worthley.
Assistant to the director, Extension Service,	John D. Zink.

[1] Resignation takes effect Dec. 18, 1920.

TABLE II. — *New Appointments.*

A. *In the Academic Departments.*

POSITION.	Name.	Degrees.
Instructor in mathematics,	Francis P. Clark,	B.Sc., Catholic University, 1920.
Instructor in entomology,	William L. Dowd,	B.Sc., Massachusetts Agricultural College, 1920.
Assistant professor of farm management.	Willard K. French,	B.Sc., Massachusetts Agricultural College, 1919.
Professor of forestry,	Laurence R. Grose,	A.B., Brown University; M.F., Harvard Forestry School.
Professor of physics,	Elmer A. Harrington,	A.B., Clark College, 1905; A.M., Clark University, 1906; Ph.D., Clark University, 1915.

TABLE II. — *New Appointments* — Continued.

A. *In the Academic Departments* — Concluded.

POSITION.	Name.	Degrees.
Instructor in market gardening, .	Roy D. Harris, . .	B.Sc., Middlebury College, 1920.
Assistant, physical education, .	Brooks F. Jakeman, .	B.Sc., Massachusetts Agricultural College, 1920.
Instructor in microbiology, . .	James Neill, . . .	B.Sc., Allegheny College.
Instructor in horticultural manufactures.	William F. Robertson, .	B.Sc., Massachusetts Agricultural College, 1920.
Instructor in poultry husbandry, .	William E. Ryan, .	B.Sc., Massachusetts Agricultural College, 1916.
Professor of animal husbandry, .	Schuyler M. Salisbury,	B.Sc., Ohio State University, 1913.
Professor of rural sociology, . .	Newell L. Sims, . .	A.M., Columbia University, 1910; Ph.D., Columbia University, 1913.
Instructor in home economics, .	Mrs. Julia G. Strahan, .	B.Sc., Teachers' College, 1920.
Instructor in animal husbandry, .	Weston C. Thayer, .	B.Sc., Massachusetts Agricultural College, 1920.
Instructor in agronomy, . .	Guy A. Thelin, . .	B.Sc., South Dakota Agricultural College, 1920.
Instructor in physics, . . .	Alfred L. Tower, . .	B.Sc., Massachusetts Agricultural College, 1914.
Instructor in dairying, . . .	Glen E. Upton, . .	B.Sc., Cornell University, 1920.
Assistant professor of dairying, .	T. George Yaxis, . .	B.Sc., New Hampshire College, 1914; M.Sc., Cornell University, 1917.

B. *In the Experiment Station.*

POSITION.	Name.	Degrees.
Director, ...	Sidney B. Haskell, .	B.Sc., Massachusetts Agricultural College, 1904.
Assistant research professor of veterinary science.	John B. Lentz, . .	A.B., Franklin and Marshall College, 1908; V.M.D., University of Pa., 1914.
Research professor of pomology, .	Jacob K. Shaw, . .	B.Sc., University of Vermont, 1899; M.Sc., Massachusetts Agricultural College, 1908; Ph.D., Massachusetts Agricultural College, 1911.
Assistant chemist, ...	Raymond W. Swift, .	B.Sc., Massachusetts Agricultural College, 1920.
Investigator in entomology, . .	Harlan N. Worthley, .	B.Sc., Massachusetts Agricultural College, 1920.

C. *In the Extension Service.*

POSITION.	Name.	Degrees.
Supervisor of Extension schools and exhibits.	Robert D. Hawley, .	B.Sc., Massachusetts Agricultural College, 1920.
Extension editor and supervisor of Correspondence Courses.	Louis M. Lyons, . .	B.Sc., Massachusetts Agricultural College, 1918.
Extension professor of farm management and demonstrations.	Allister F. McDougall, .	B.Sc., Massachusetts Agricultural College, 1913.
Extension professor of agricultural economics.	Robert J. McFall, .	A.B., Geneva College, 1912; A.M., Glasgow University, 1914; Ph.D., Columbia University, 1916.
Extension assistant professor of landscape gardening.	William E. Philbrick,[1] .	B.Sc., Massachusetts Agricultural College, 1912.
Assistant State home demonstration agent.	Lucy M. Queal,[2] . .	B.Sc., Teachers' College, 1920.
Extension assistant professor of home economics.	Mrs. Ruth S. Reed, .	- - -
Assistant State home demonstration agent.	Marie Sayles, . .	M.Sc., Teachers' College.

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[1] To take effect Jan. 1, 1921.

[2] Temporary.

TABLE II. — *New Appointments* — Continued.

D. Miscellaneous.

POSITION.	Name.	Degrees.
Field agent,	George M. Campbell,	B.Sc., Massachusetts Agricultural College, 1920.
Resident nurse,	Grace Charman,	– – –
Resident nurse,	Marguerite Davis,	– – –
Superintendent of dairy manufactures.	Adelbert Sheffield,	– – –

E. In the Clerical Staff.

POSITION.	Name.
Library assistant,	Florence Archibald.
Stenographer, Extension Service,	Mrs. Esther W. Arp.
Stenographer, Department of Rural Home Life,	May G. Arthur.
Clerk, Department of Microbiology,	Mrs. Celena M. Baxter.
Clerk, Department of Dairying,	Ruth L. Brown.
Library assistant,	Margery Burnett.
Bookkeeper, treasurer's office,	Grace Corbett.
Stenographer, Extension Service,	Florence E. Day.
Stenographer, Department of Rural Sociology,	Rose Delaney.
Clerk, power plant,	Hazel Donovan.
Stenographer, president's office,	Margaret Fish.
Stenographer, Department of Agronomy,	Katherine Harris.
Clerk, Department of Physical Education,	E. Franklin Holland.
Stenographer, dean's office,	Gertrude E. Hollis.
Stenographer, president's office,	Catharine E. Honney.
Cataloguer, library,	Florence B. Kimball.
Stenographer, Division of Agriculture,	Aline J. Legare.
Stenographer, treasurer's office,	Marion B. Macarty.
Stenographer, Market-Garden Field Station,	Edith Meehan.
Assistant librarian,	Katherine Middleton.
Stenographer, Extension Service,	Doris Millett.
Clerk, treasurer's office,	Mrs. Jessie A. Neill.
Stenographer, registrar's office,	Julietta O'Donnell.
Clerk, Extension Service,	Corinne T. Petit.
Stenographer, Extension Service,	Mildred Putney.
Private Secretary, Division of Rural Social Science,	Helen M. Rand.
Stenographer, Extension Service,	Helen Reardon.

TABLE II. — *New Appointments* — Concluded.

E. In the Clerical Staff — Concluded.

POSITION.	Name.
Stenographer, Extension Service,	Josephine B. Reed.
Clerk, treasurer's office,	Mrs. Ruth L. Rodwaye.
Stenographer, Division of Horticulture,	Ora E. Rouleau.
Clerk, Extension Service,	Sadie Shores.
Clerk, president's office,	Harriet A. Smith.
Clerk, Department of Agricultural Economics,	Mary A. Smith.
Clerk, treasurer's office,	Miriam Spencer.
Stenographer, Extension Service,	Catherine White.
Stenographer, Extension Service,	Mrs. Ruth S. Worthley.

TABLE III. — *Speakers for the Year.*

A. Speakers at Wednesday Assembly for Year ending Nov. 30, 1920.

1919.
Dec. 3. — Prof. Harold Whitehead, Boston University, Boston.
Dec. 10. — Prof. Winthrop S. Welles, M. A. C.
Dec. 31. — Prof. Frank A. Waugh, M. A. C.

1920.
Jan. 7. — Student forum.
Jan. 14. — Prof. Ernest Barker, Oxford University, England.
Jan. 21. — Mr. Sam Higginbottom, India.
Jan. 28. — Signora Agresti, Rome.
Feb. 4. — Dr. Rosalie S. Morton, New York City.
Feb. 11. — Hon. Allen T. Treadway, Washington, D. C.
Feb. 18. — Student forum conducted by Prof. R. J. Sprague.
Feb. 25. — Mr. Walter H. Smith, Manchester, N. H.
Mar. 3. — Student forum.
Mar. 10. — Student forum.
Mar. 31. — Student forum conducted by Prof. R. J. Sprague.
Apr. 7. — Director John D. Willard, M. A. C.
Apr. 14. — Student forum conducted by Prof. R. J. Sprague.
Apr. 21. — Rev. Harold Marshall, Boston.
Apr. 28. — Student forum.
May 5. — Mr. Charles A. Lyman, Washington, D. C.
May 12. — Freshman-Sophomore debate.
May 19. — Rev. J. Burford Parry, Springfield.
June 2. — Burnham prize contest.
June 9. — Prof. L. H. Bailey, Ithaca, N. Y.
Sept. 29. — Pres. Kenyon L. Butterfield.
Oct. 6. — Student forum.
Oct. 13. — Mr. J. Horace McFarland, Harrisburg, Pa.
Oct. 20. — Mr. Ezra L. Morgan, Washington, D. C.
Oct. 27. — Student forum.
Nov. 3. — Mr. Roger W. Babson, Wellesley, Mass.
Nov. 10. — Pres. Frank P. Speare, Boston.
Nov. 17. — Mr. George T. Powell, Brookfield.

B. Speakers at Sunday Chapel for Year ending Nov. 30, 1920.

1919.
Dec. 7. — Rev. Samuel A. Eliot, Boston.
Dec. 14. — Rev. William H. Day, Bridgeport, Conn.

1920.
Jan. 4. — Rev. William A. Atkinson, Amherst.
Jan. 11. — Bishop Edwin H. Hughes, Malden.
Jan. 18. — Rev. Jason Noble Pierce, Dorchester
Jan. 25. — Dr. William E. Strong, Boston.
Feb. 1. — Dr. Sidney L. Gulick, New York City.
Feb. 8. — Mr. Alfred E. Stearns, Andover.
Feb. 15. — Rev. W. W. Weeks, Springfield.
Feb. 22. — Mr. Hamilton Holt, New York City.
Feb. 29. — Mr. Albert E. Roberts, New York City.
Mar. 7. — Dr. John Herman Randall, New York City.
Mar. 14. — Rev. J. Burford Parry, Springfield.
Apr. 4. — Dr. John M. Tyler, Amherst.
Apr. 11. — Rev. J. Edgar Park, West Newton.
Apr. 18. — Pres. John M. Thomas, Middlebury, Vt.
Apr. 25. — Rev. Archibald Black, Boston.
Oct. 3. — Pres. Kenyon L. Butterfield.
Nov. 7. — Hon. William H. Taft, New Haven, Conn.
Nov. 14. — Rev. John Herman Randall, New York City.
Nov. 21. — Rev. William A. Atkinson, Amherst.

TABLE IV. — *Attendance.*

A. In Work of College Grade.

CLASS.	REGISTRATION NOV. 30, 1919.			REGISTRATION NOV. 30, 1920.		
	Men.	Women.	Total.	Men.	Women.	Total.
Graduate students,	31	2	33	41	7	48
Senior class,	110	3	113	94	3	97
Junior class,	100	3	103	94	5	99
Sophomore class,	108	4	112	96	8	104
Freshman class,	116	9	125	124	11	135
Unclassified students,	24	9	33	9	1	10
Special students,	–	–	–	11	2	13
Totals,	489	30	519	469	37	506

B. Short Course Enrollment.

Two-Year Course, second year,	18	–	18	125	10	135
Two-Year Course, first year,	183	8	191	130	12	142
Vocational Poultry Course,	13	–	13	19	–	19
Rural Engineering Course,	16	–	16	–	–	–
Unit Course,	–	–	–	50	–	50
Totals,	230	8	238	314	22	336

TABLE IV. — *Attendance* — Concluded.

C. Other Short Course Enrollment.

	REGISTRATION 1918-19.			REGISTRATION 1919-20.		
	Men.	Women.	Total.	Men.	Women.	Total.
Winter school,	43	20	63	90	22	112
Summer school,	46	192	238	107	150	257
Summer school for Federal men,	31	–	31	65	–	65
Six weeks' course,	22	1	23	–	–	–
Totals,	142	213	355	262	172	434

D. Convention Registration.

	1919.	1920.
Farmers' week,	898	1,301
County agents' conference,	30	85
Poultry convention,	200	400
Boys' camps,	52	160
Girls' camp,	33	186
	1,213	2,132

TABLE V. — *Legislative Budget, 1920.*

ITEMS.	Amount asked.	Amount granted.
Library building and equipment,	$425,000	–
Chemistry laboratory,	600,000	–
Miscellaneous improvements and equipment,	120,000	$50,000
House for farm help,	5,000	–
Extension for rural engineering shops,	25,000	–
Improvements at power and heating plant,	80,000	–
Stable for cavalry unit,	15,000	15,000
	$1,270,000	$65,000

TABLE VI. — *Current Account, State Funds.*

	Requested 1920.	Appropriated 1920.	Deficiency Appropriation.[1]	Expended 1920.	Balance.
Personal services: —					
Administration,	$40,220	$38,000	–	$38,082 71	—$82 71
Instruction,	170,350	159,000	+$215 56	149,319 85	9,895 71
General maintenance,	112,285	108,000	+145 65	110,672 91	—2,527 26
Experiment Station,	62,510	41,000	–	43,060 36	—2,060 36
Extension Service,	125,260	54,000	+5 60	48,371 91	5,633 69
Market-Garden Field Station,	5,400	5,400	–	5,277 29	122 71
Short Courses,	27,270	25,600	–	27,306 65	—1,706 65
Travel, office and other expenses.	41,325	41,000	+3,382 68	47,790 04	—3,407 36
Teaching, laboratory supplies and equipment.	70,600	67,000	+2,333 81	60,667 72	8,666 09
Experiment Station: —					
Supplies and equipment,	14,050	10,000	+717 53	13,989 17	—3,271 64
Travel and office expenses,	6,550	5,000	+99 16	3,314 54	1,784 62
Extension Service, supplies, equipment, travel, etc.	68,130	40,000	+976 28	36,416 55	4,559 73
Short Courses,	14,475	14,000	+56 45	7,940 56	6,115 89
Heat, light and power,	45,000	45,000	+325 95	65,803 86	—20,477 91
Farm,	26,780	26,780	+2,615 72	35,267 65	—5,871 93
Repairs, ordinary,	17,000	17,000	+132 00	16,898 28	233 72
Replacements,	5,000	3,700	–	2,644 54	1,055 46
Market-Garden Field Station,	3,000	3,000	+50 12	2,680 21	369 91
Fertilizer law control,	12,500	12,500	+83 93	12,410 84	173 09
Poultry disease law,	4,000	3,000	+263 28	3,064 98	198 30
Milk-testing inspection law,	550	550	–	525 08	24 92
Trustees, expenses,	1,200	1,200	+134 86	798 39	536 47
Printing reports,	6,000	5,500	–	1,641 27	3,858 73
Commercial feedstuffs,	6,000	6,000	+17 00	5,769 91	249 09
Totals,	$858,455	$732,230	$11,555 58	$739,713 27	$4,072 31

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[1] Deficiency appropriation to meet expenses incurred in 1918–19.

TABLE VII. — *Statistics of Freshmen entering Massachusetts Agricultural College, September, 1920.*

A. Home Addresses of Students (classified by Towns and Cities).

Adams,	1	Hadley,	1	Orange,	2
Amherst,	10	Hatfield,	1	Pepperell,	1
Ashfield,	1	HAVANA, CUBA,	1	PITTSFIELD,	1
ATTLEBORO,	1	Holbrook,	1	PROVIDENCE, R. I.,	1
Barre,	1	Holden,	1	QUINCY,	3
Belchertown,	1	HOLYOKE,	3	Rajputana, India,	1
Belgrade, Serbia,	1	Homestead, Pa.,	1	Rehoboth,	1
Belmont,	1	Kensington, Md.,	1	REVERE,	1
Bernardston,	1	Lancaster,	1	Rockland,	2
BEVERLY,	1	Larchmont, N. Y.,	1	Royalston,	1
Bloomfield, N. J.,	1	LEOMINSTER,	1	Shelburne,	2
Bosnia, Serbia,	1	LOWELL,	1	SOMERVILLE,	1
BOSTON,	6	LYNN,	1	SPRINGFIELD,	2
Bound Brook, N. J.,	1	Mansfield,	1	Suffield, Conn.,	1
BROCKTON,	2	Marblehead,	1	Summit, N. J.,	1
Brookline,	2	MARLBOROUGH,	1	Sunderland,	1
CAMBRIDGE,	5	Medfield,	1	Swampscott,	1
Camden, Me.,	1	MEDFORD,	1	TAUNTON,	1
Charlestown, N. H.,	1	MELROSE,	2	Townsend,	1
Chepachet, R. I.,	1	Milford,	1	WALTHAM,	1
Chester,	1	Millville,	1	Ware,	1
Concord,	1	Milton,	1	Wareham,	1
Deerfield,	1	Montague,	2	Webster,	1
East Bridgewater,	1	Needham,	1	Weehawken, N. J.,	1
East Longmeadow,	1	New Platz, N. Y.,	1	West Bridgewater,	2
FALL RIVER,	1	NEW YORK, N. Y.,	1	WESTFIELD,	3
FITCHBURG,	3	NEWTON,	5	Westport,	1
Framingham,	1	NORTHAMPTON,	1	Wilbraham,	4
GLOUCESTER,	1	North Andover,	1	WORCESTER,	3
Greenfield,	2	Oakham,	1	WILLIMANTIC, CONN.,	1

B. Home Addresses (classified by States).

	Number.	Per Cent.		Number.	Per Cent.
Connecticut,	2	1.48	New Jersey,	4	2.97
Cuba,	1	.74	New York,	3	2.22
India,	1	.74	Pennsylvania,	1	.74
Maine,	1	.74	Rhode Island,	2	1.48
Maryland,	1	.74	Serbia,	2	1.48
Massachusetts,	116	85.93		135	100.00
New Hampshire,	1	.74			

TABLE VII. — *Statistics of Freshmen entering Massachusetts Agricultural College, September, 1920* — Continued.

C. Home Addresses (classified by Counties of Massachusetts).

	Number.	Per Cent.		Number.	Per Cent.
Berkshire,	2	1.72	Middlesex,	22	18.97
Bristol,	6	5.17	Norfolk,	9	7.76
Essex,	6	5.17	Plymouth,	8	6.90
Franklin,	12	10.35	Suffolk,	7	6.03
Hampden,	14	12.07	Worcester,	15	12.93
Hampshire,	15	12.93		116	100.00

D. Nativity of Parents.

	Number.	Per Cent.
Neither parent foreign born,	93	68.89
Both parents foreign born,	23	17.04
Father (only) foreign born,	8	5.93
Mother (only) foreign born,	10	7.40
No statistics,	1	.74
	135	100.00

E. Education of Father.

	Number.	Per Cent.
Common school,	56	41.48
High school,	31	22.96
Business school,	11	8.15
College or university,	33	24.45
No statistics,	4	2.96
	135	100.00

TABLE VII. — *Statistics of Freshmen entering Massachusetts Agricultural College, September, 1920* — Continued.

F. Religious Census.

	Membership.		Preference.		Totals.	
	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Baptist,	9	6.67	2	1.48	11	8.15
Catholic,	13	9.63	2	1.48	15	11.11
Congregationalist,	39	28.89	15	11.12	54	40.00
Episcopal,	10	7.41	1	.74	11	8.15
Methodist,	6	4.44	6	4.44	12	8.89
Presbyterian,	3	2.22	–	–	3	2.22
Unitarian,	8	5.93	3	2.22	11	8.15
Universalist,	3	2.22	2	1.48	5	3.70
Miscellaneous,	7	5.19	5	3.70	12	8.89
No statistics,	1	.74	–	–	1	.74
	99	73.34	36	26.66	135	100.00

G. Occupation of Father.

	Number.	Per Cent.
Agriculture and horticulture,	28	20.75
Artisans,	29	21.49
Business,	33	24.43
Deceased or no statistics,	14	10.37
Miscellaneous,	15	11.11
Professional,	16	11.85
	135	100.00

H. Intended Vocation of Student.

	Number.	Per Cent.
Agriculture or horticulture (practical),	57	42.23
Agriculture or horticulture (professional),	39	28.89
Professions,	3	2.22
Miscellaneous,	5	3.70
Undecided or no statistics,	31	22.96
	135	100.00

Table VII. — *Statistics of Freshmen entering Massachusetts Agricultural College, September, 1920* — Concluded.

I. Farm Experience.

	Number.	Per Cent.
Brought up on a farm,	43	31.85
Not brought up on a farm and having no or practically no farm experience.	26	19.26
Not brought up on a farm, but having had some farm experience,	66	48.89
	135	100.00

J. Miscellaneous Statistics.

Average age, ... 19.30 years

Table VIII. — *Cases treated at the Infirmary Dec. 1, 1919, to Nov. 30, 1920.*

	Daily Count.	Individual.
1919		
December 1 to 31: —		
House cases,	29	7
Out-patients,	84	41
1920		
January 1 to 31: —		
House cases,	143	35
Out-patients,	159	94
February 1 to 29: —		
House cases,	189	23
Out-patients,	59	47
March 1 to 31: —		
House cases,	12	4
Out-patients,	33	22
April 1 to 30: —		
House cases,	43	6
Out-patients,	35	20
May 1 to 31: —		
House cases,	23	5
Out-patients,	68	21
June 1 to 30: —		
House cases,	17	2
Out-patients,	43	10
September 15 to 30: —		
House cases,	1	1
Out-patients,	11	7
October 1 to 31: —		
House cases,	98	15
Out-patients,	72	33
November 1 to 30: —		
House cases,	96	12
Out-patients,	66	31

Number of house cases,	651	
Number of out-patients,	630	
Total,		1,281
Number cared for in the house,	110	
Number cared for as out-patients,	326	
Total,		436

TABLE IX. — *Selected List of Publications of the Officers of the Institution (December, 1919 — November, 1920).*

ARNY, L. WAYNE. Supervisor of Correspondence Courses.

Editing the Farm Bureau Paper. Massachusetts Agricultural College. Extension Service. Extension Bulletin No. 28, December, 1919. 20 p.

BEALS, CARLOS L. Assistant Research Professor of Chemistry.

The Nutritive Value of Cattle Feeds. I. Velvet Bean Feed for Farm Stock. Massachusetts Agricultural Experiment Station. Bulletin No. 197, September, 1920. p. 61-74.

The Nutritive Value of Cattle Feeds. II. Oat Feed for Farm Stock. Massachusetts Agricultural Experiment Station. Bulletin No. 200, November, 1920.

BOURNE, A. I. Investigator in Entomology.

Aphids or Plant Lice. Massachusetts Agricultural College. Extension Service. Extension Circular No. 79 M, 1920. 3 p.

BROOKS, WILLIAM P. Consulting Agriculturist.

A Fertilizer Experiment with Asparagus. Massachusetts Agricultural Experiment Station. Bulletin No. 194, December, 1919. p. 231-257.

Methods of Applying Manure. Massachusetts Agricultural Experiment Station. Bulletin No. 196, September, 1920. p. 39-60.

BUTTERFIELD, KENYON L. President.

The Present Crisis. Baccalaureate Address. Massachusetts Agricultural College, June 20, 1920. Abstract in "Springfield Republican," June 20, 1920.

President's Address. In Proceedings of the Third National Country Life Conference, October, 1920.

CANCE, ALEXANDER E. Professor of Agricultural Economics.

Prepare for the Census Taker. In County Farm Bureau Bulletins, December, 1919.

CHAPMAN, GEORGE H. Research Professor of Botany.

Curing and Fermentation Troubles of Tobacco and their Control. Massachusetts Agricultural College. Extension Service. Extension Bulletin No. 36, July, 1920. 15 p.

Tobacco Investigations Progress Report. Massachusetts Agricultural Experiment Station. Bulletin No. 195, March, 1920. 38 p.

CHENOWETH, WALTER W. Professor of Horticultural Manufactures.

O Sweet, Sweet Cider! In Middlesex County Bulletin, December, 1919. p. 12.

COLE, WILLIAM R. Assistant Extension Professor of Horticultural Manufactures.

Home Storage. In New England Farms, Vol. 50, No. 45, Nov. 6, 1920. p. 8.

Home Storage Room Plans. In Bristol County Farmers' Bulletin, October, 1920. p. 4.

Old Cellar Holes may be Reconstructed. In Middlesex County Bulletin, May, 1920. p. 9.

A Reason for Storing Apples. In Berkshire Farmers' Bulletin, May, 1920. p. 8, 9.

COOLEY, ROY B. Assistant Extension Professor of Animal Husbandry.

Choosing Dairy Cattle Feeds. In County Farm Bureau Bulletins, March and May, 1920.

Food Advisory Report. In County Farm Bureau Bulletins, April, 1920.

Pure Bred Sires Gaining. In County Farm Bureau Bulletins, May and June, 1920.

Why Balanced Rations? In County Farm Bureau Bulletins, July and August, 1920.

Wintering Brood Sows. In County Farm Bureau Bulletins, December, 1919.

CRAMPTON, GUY C. Professor of Insect Morphology.

Some Anatomical Details of the Remarkable Winged Zorapteron, Zorotypus Hubbardis Caudell, with the Notes on its Relationships. Proc. Ent. Soc., Washington, Vol. 22, No. 5, 1920. p. 98-106.

Remarks on the Basic Plan of the Terminal Abdominal Structures of the Males of Winged Insects. Canadian Entomologist, Vol. 52, No. 8, 1920. p. 178-183.

The Terminal Abdominal Structures of the Primitive Australian Termite, Mastotermes Darwinensis Froggatt. Trans. Ent. Soc., London, 1920. p. 137-145.

Remarks on Dr. MacGillivray's Paper entitled "The Eyes of Insects." Entomological News, Vol. 31, 1920. p. 153-155.

A Comparison of the External Anatomy of the Lower Lepidoptera and Trichoptera from the Standpoint of Phylogeny. Psyche, Vol. 27, 1920. p. 23-34.

A Comparison of the Genitalia of Male Hymenoptera, Mecoptera, Neuroptera, Diptera, Trichoptera, Lepidoptera, Homoptera and Strepsiptera, with those of lower insects. Psyche, Vol. 27, 1920. p. 34-46.

DACY, ARTHUR L. Professor of Vegetable Gardening.

Asparagus Growing in Massachusetts. In Massachusetts Agricultural College. Extension Service. Extension Bulletin No. 35, May, 1920. 10 p.

FARLEY, GEORGE L. Supervisor of Junior Extension Work.

Corn Club Primer, by Earl Jones, G. L. Farley and W. F. Howe. Massachusetts Agricultural College. Extension service. Junior Extension Series No. 9, April, 1920. 4 p.

Junior Extension Account Books. Corn Club, Potato Club, and Garden Club. Massachusetts Agricultural College. Extension Service. Junior Extension Series No. 8, April, 1920. 3 vols.

Junior Extension Work. Massachusetts Agricultural College. Extension Service. Junior Extension Series No. 11, April, 1920. 7 p.

Potato Club Primer, by Earl Jones, G. L. Farley and W. F. Howe. Massachusetts Agricultural College. Extension Service. Junior Extension Series No. 10, April, 1920. 4 p.

FERNALD, HENRY T. Professor of Entomology.

Asparagus Insects. In Massachusetts Agricultural College. Extension Service. Extension Bulletin No. 35, May, 1920. p. 11, 12.

The European Corn Borer. In Nebraska Farmer, Vol. 62, No. 15, 1920. p. 1065.

Ten Years of the Oriental Moth. Journal of Economic Entomology, Vol. 13, No. 2, April, 1920. p. 210–212.

FRANKLIN, HENRY J. In Charge of Cranberry Investigations.

Cape Cod Cranberry Frosts. In United States Department of Agriculture. Monthly Weather Review, Supplement No. 16. p. 20–30.

GOODALE, HUBERT D. Research Professor of Poultry Husbandry.

Data concerning the Inheritance of Broodiness in the Rhode Island Red Breed of Domestic Fowl. Massachusetts Agricultural Experiment Station, Bulletin No. 199, November, 1920.

HASLETT, HENRY E. Specialist in Sheep Husbandry.

Care of Ewes during Fall and Winter. In County Farm Bureau Bulletins, December, 1919, and January, 1920.

Harvest Time for the Shepherd. In Berkshire Farmers' Bulletin, April, 1920. p. 1–4.

More Money in Docked and Castrated Lambs. In Berkshire Farmers' Bulletin, May, 1920. p. 11, 12.

HOWE, WILLIAM F. Assistant Supervisor in Junior Extension Work.

Corn Club Primer, by Earl Jones, G. L. Farley and W. F. Howe. Massachusetts Agricultural College. Extension Service. Junior Extension Series No. 9, April, 1920. 4 p.

Garden Primer, Massachusetts Boys' and Girls' Clubs. Massachusetts Agricultural College. Extension Service. Junior Extension Series No. 7, April, 1920. 15 p.

Potato Club Primer, by Earl Jones, G. L. Farley and W. F. Howe. Massachusetts Agricultural College. Extension Service. Junior Extension Series No. 10, April, 1920. 4 p.

JONES, EARL. Extension Professor of Agronomy.

Alfalfa and Soy Beans gain by its Use. In Hampshire County Farm Bureau Monthly, April, 1920. p. 5.

Corn Club Primer, by Earl Jones, G. L. Farley and W. F. Howe. Massachusetts Agricultural College. Extension Service. Junior Extension Series No. 9, April, 1920. 4 p.

Good Seed Corn. In Berkshire Farmers' Bulletin, September, 1920. p. 10.

Making Bordeaux Mixture. In County Farm Bureau Bulletins, July, 1920.

Plant Sweet Corn as Usual. In Berkshire Farmers' Bulletins, May, 1920. p. 10.

Potato Club Primer, by Earl Jones, G. L. Farley and W. F. Howe. Massachusetts Agricultural College. Extension Service. Junior Extension Series No. 10, April, 1920. 4 p.

Seed Corn Testing Low. In County Farm Bureau Bulletins, April, 1920.

Soil and Glue Method of Inoculating Legume Seed. In County Farm Bureau Bulletins, May and April, 1920.

Soy Beans for Silage. In Middlesex County Bulletin for May, 1920. p. 7.

Spraying Potatoes with Bordeaux will increase the Yield. In Bristol County Farmers' Bulletin, June, 1920. p. 2.

Weather prevents Drying. In Middlesex County Bulletin, December, 1919. p. 5.

What is the Analysis of the Fertilizers you are Buying? In County Farm Bureau Bulletins, March, 1920.

LINDSEY, JOSEPH B. Professor of Agricultural Chemistry.

The Nutritive Value of Cattle Feeds. I. Velvet Bean Feed for Farm Stock. Massachusetts Agricultural Experiment Station. Bulletin No. 197, September, 1920. p. 61–74.

The Nutritive Value of Cattle Feeds. II. Oat Feed for Farm Stock. Massachusetts Agricultural Experiment Station. Bulletin No. 200, November, 1920.

Semi-solid Buttermilk. In Berkshire Farmers' Bulletin, February, 1920. p. 9, 10.

LYONS, LOUIS M. Editor of Extension Publications.

M. A. C. at Eastern States Exposition. In New England Farms, Vol. 3, No. 41, Oct. 9, 1920. p. 3.

M. A. C. opens. In New England Farms, Vol. 3, No. 42, Oct. 16, 1920. p. 2, 3.

Monahan, William C. Extension Professor of Poultry Husbandry.
Breeding for Egg Production. In County Farm Bureau Bulletins, February, 1920.
Brooding Sanitation. In County Farm Bureau Bulletins, March, 1920.
Feeding Chicks. In Berkshire Farmers' Bulletin, April, 1920. p. 8, 9.
Lice, Mites and their Control. In County Farm Bureau Bulletins, July, 1920.
Poultry Feeding. Massachusetts Agricultural College. Extension Service. Extension Bulletin No. 33, December, 1919. 8 p.
Poultry Feeding. Massachusetts Agricultural College. Extension Service. Extension Bulletin No. 33 (2d ed.), July, 1920. 8 p.
Poultry Pointers. In Hampshire County Farm Bureau Monthly, May, 1920. p. 5-7.
Poultry Suggestions. In Bristol County Farmers' Bulletin, March, 1920. p. 4.
Round Worms in Poultry. In County Farm Bureau Bulletins, October, 1920.

Morse, Fred W. Research Professor of Chemistry.
A Fertilizer Experiment with Asparagus. Massachusetts Agricultural Experiment Station. Bulletin No. 194, December, 1919. p. 231-257.
Studies of Cranberries during Storage. Massachusetts Agricultural Experiment Station. Bulletin No. 198, September, 1920.

Nodine, Earle H. Extension Instructor in Charge of Poultry Club Work.
Brooding Methods are Very Important. In Middlesex County Bulletin, April, 1920. p. 13.
Many will want to Hatch "Chicks." In Middlesex County Bulletin, March, 1920. p. 12.
Overfeeding causes Loss of Many Chicks. In Middlesex County Bulletin, May, 1920. p. 13.
Primer of Instruction. Massachusetts Boys' and Girls' Poultry Clubs. Massachusetts Agricultural College. Extension Service. Boys' and Girls' Series, No. 11, May, 1920. 9 p.

Norris, Helen M. Extension Instructor in Agricultural Education.
Every Girl should try to Look Nice. In Middlesex County Bulletin, March, 1920. p. 13.
Massachusetts Junior Extension Canning Club Bulletin. Massachusetts Agricultural College. Extension Service. Junior Extension Series No. 12, June, 1920. 14 p.

Rand, Frank P. Instructor in English.
Editorials in The Signet, December, 1919, March, June and September, 1920. The Golden Rule and College Fraternities. In Banta's Greek Exchange, Vol. 8, No. 3, July, 1920. p. 311-314.

Regan, W. S. Assistant Professor of Entomology.
Progress in the Use of Chemicals for Destroying Rives. In American Plant Pest Commission Report, 1920.

Sears, Fred C. Professor of Pomology.
Grape Growing in Massachusetts. Massachusetts Agricultural College. Extension Service. Extension Bulletin No. 32, February, 1920. 25 p.
Productive Small Fruit Culture. Philadelphia. Lippincott, 1920. 368 p.
Spraying the Apple Orchards. Massachusetts Agricultural College. Extension Service. Extension Bulletin No. 34, May, 1920. 8 p.

Sims, Newell L. Professor of Rural Sociology.
The Rural Community, Ancient and Modern. New York. Scribner, 1920. 916 p.
Rural Socialization. In Political Science Quarterly, Vol. 35, No. 1, March, 1920.

Smith, Philip H. Chemist in Charge of Feed and Dairy Section.
Inspection of Commercial Feed Stuffs, 1920. Massachusetts Agricultural Experiment Station. Control Series No. 13, November, 1920.

Strahan, James L. Assistant Professor of Rural Engineering.
Framing of Large Barns. In Builders' Journal, October, 1920.

Tompson, Harold F. Professor of Vegetable Gardening.
New England Notes in Market Growers' Journal, December, 1919-November, 1920.
Functions of its Work are Three in Number. In Middlesex County Bulletin, April, 1920. p. 10.
The Home Vegetable Garden. In County Farm Bureau Bulletins, May and June, 1920.
Market Garden Notes. In Berkshire Farmers' Bulletin, May and June, 1920.
Market Gardeners' Field Trip. In Bristol County Farmers' Bulletin, June, 1920. p. 4.
Seed Buying and Seed Testing. In County Farm Bureau Bulletins, February and March, 1920.

Van Meter, Ralph A. Assistant Extension Professor of Pomology.
Care of Bridge-grafted Trees. In County Farm Bureau Bulletins, June and October, 1920.
Many Orchards need Fertilization. In Berkshire Farmers' Bulletin, June, 1920. p. 5.
Protect Fruit Trees from Mice. In Bristol County Farmers' Bulletin, October, 1920. p. 4.
Spray Your Apple Trees. In Berkshire Farmers' Bulletin, April, 1920. p. 6, 7.

WAUGH, FRANK A. Professor of Landscape Gardening.

Apple Butter. In Country Gentleman, Vol. 84, No. 47, Dec. 6, 1919, p. 67.

The Game. In Country Gentleman, Vol. 85, No. 42, Oct. 16, 1920. p. 32.

Going! Going! Almost gone! In Country Gentleman, Vol. 85, No. 18, May 1, 1920. p. 6, 54.

How Many Apple Trees? In Country Gentleman, Vol. 85, No. 27, July 3, 1920. p. 12, 34.

Occupational Therapy in Tuberculosis. Typewritten volume, 1919, photos. 41 p.

Occupational Therapy in Tuberculosis. In Scientific Monthly, Vol. 10, No. 5, May, 1920. p. 438–456.

The Opportunities of the Country Village. In House Beautiful, Vol. 48, No. 4, October, 1920. p. 276, 277, 312.

Recreational Forestry. In The Playground, Vol. 14, No. 4, July, 1920. p. 219–225.

A Restudy of Plans for the College Grounds and for the Location of Buildings. 1920. 37 p.

Seven Mountains of Massachusetts. In Springfield Republican, Feb. 1, 1920.

A Side Line of Fruit: How You can make it Pay on Your Farm. In Farm and Fireside, Vol. 44, No. 1, January, 1920. p. 17, 56.

Those Dear Old Whims. In Country Gentleman, Vol. 85, No. 20, May 15, 1920. p. 13, 58.

The Tree Planter's Problem. In Country Gentleman, Vol. 85, No. 16, April 17, 1920. p. 6, 58.

Useful Landscape Gardening on the Farm. In Farmers' Advocate, Vol. 54, December, 1919. p. 2218.

What We do in the Country — Music. In Country Gentleman, Vol. 84, No. 50, Dec. 13, 1919. p. 15, 32.

Where shall We Ride To-day? In Springfield Republican, April 18, 1920.

REPORT OF THE TREASURER

FOR THE FISCAL YEAR ENDING NOV. 30, 1920.

BALANCE SHEET.

		DR.	CR.
1919			
Dec. 1.	To balance on hand, ...	$30,442 21	
1920			
Nov. 30.	To departmental income, ...	151,201 82	
Nov. 30.	To receipts from State Treasurer, ...	772,665 70	
Nov. 30.	To November, 1919, schedule, ...	66,413 37	
Nov. 30.	To refunds to State Treasurer, ...	32 60	
Nov. 30.	To receipts from United States Treasurer, . . .	122,541 26	
Nov. 30.	To September and October schedule in transit, . .	16,990 50	
Nov. 30.	To November schedule in transit, ...	99,195 06	
Nov. 30.	Expenditures of November, 1919, schedule paid in this fiscal year.		$66,413 37
Nov. 30.	Refunds transferred to State Treasurer, ...		32 60
Nov. 30.	Expenditure for fiscal year, ...		1,004,514 74
Nov. 30.	Income transferred to State Treasurer, ...		151,201 82
Nov. 30.	Balance on hand, ...		37,319 99
		$1,259,482 52	$1,259,482 52

STATEMENT OF LEGISLATIVE APPORTIONMENT AND EXPENDITURES FOR FISCAL YEAR ENDING NOV. 30, 1920, AND APPORTIONMENT REQUESTED FOR 1921.

	Apportionment for Last Fiscal Year.		Expenditures.		Requested Apportionment for New Fiscal Year.	
College: —						
Personal services, .	$305,361 21		$298,075 47		$426,437 00	
Maintenance, . .	209,270 16	$514,631 37	229,072 09	$527,147 56	269,430 00	$695,867 00
Experiment Station: —						
Personal services, .	$41,000 00		$43,060 36		$111,481 00	
Maintenance, . .	15,816 69	56,816 69	17,303 71	60,364 07	25,280 00	136,761 00
Extension Service: —						
Personal services, .	$54,005 60		$48,371 91		$121,530 00	
Maintenance, . .	40,976 28	94,981 88	36,416 55	84,788 46	67,200 00	188,730 00
Short Courses: —						
Personal services, .	$25,600 00		$27,306 65		$45,133 00	
Maintenance, . .	14,056 45	39,656 45	7,940 56	35,247 21	20,275 00	65,408 00
Market-Garden and Field Station: —						
Personal services, .	$5,400 00		$5,277 29		$6,000 00	
Maintenance, . .	3,050 12	8,450 12	2,680 21	7,957 50	3,000 00	9,000 00
Totals, . . .		$714,536 51		$715,504 80		$1,095,766 00

STATEMENT OF LEGISLATIVE APPORTIONMENT AND EXPENDITURES FOR FISCAL YEAR ENDING NOV. 30, 1920, AND APPORTIONMENT REQUESTED FOR 1921 — *Concluded.*

	Apportionment for Last Fiscal Year.	Expenditures.	Requested Apportionment for New Fiscal Year.
Trustees, travel, . .	$1,334 86	$798 39	$1,200 00
Printing reports, . .	5,500 00	1,641 27	5,500 00
Commercial feedstuffs, .	6,017 00	5,767 91	8,000 00
Totals, . . .	$727,388 37	$723,712 37	$1,110,466 00
Fertilizer law, . .	12,583 93	12,410 84	14,500 00
Poultry disease law, .	3,263 28	3,064 98	6,000 00
Milk testing law, . .	550 00	525 08	600 00
Totals, . . .	$743,785 58	$739,713 27	$1,131,566 00
Balance unexpended, .	–	4,072 31	–
	–	$743,785 58	–

CASH STATEMENT.

	Other Funds.	State Funds.	Totals.
Balance Dec. 1, 1919, ...	$30,442 21	–	$30,442 21
Receipts.			
College receipts from students and others, .	. . . .	. . .	$15,055 63
Tuition, ...	–	$3,045 00	
Laboratory fees, ...	–	6,435 13	
Rents, ...	–	5,575 50	
Department sales, ...	. . . .	. . .	101,491 12
Produce, ...	–	97,292 03	
Miscellaneous, ...	–	4,199 09	
Experiment Station, ...	. . . .	. . .	8,044 81
Cranberry receipts, ...	–	3,912 35	
Chemical receipts, ...	–	2,425 11	
Miscellaneous, ...	–	1,707 35	
Extension Service, ...	. . . .	. . .	2,537 39
Correspondence Courses, ...	–	643 00	
Miscellaneous, ...	–	1,894 39	
Short Courses, ...	. . . .	. . .	4,810 25
Students' fees, ...	–	4,353 50	
Summer School, ...	–	31 75	
Winter School, ...	–	425 00	
Market-Garden Field Station, ...	. . . .	. . .	2,286 34
Produce, ...	–	2,286 34	
Fertilizer law, ...	–	14,798 17	14,798 17
Milk testing law, ...	–	709 93	709 93
Poultry disease law, ...	–	1,468 18	1,468 18
Treasurer of the Commonwealth, ...	. . . .	. . .	772,665 70
Maintenance, ...	–	628,031 46	
Special appropriations, ...	–	141,320 92	
Endowment, ...	$3,313 32	–	

Cash Statement — *Concluded.*

	Other Funds.	State Funds.	Totals.
Receipts — Concluded.			
Federal government,			$122,541 26
Land grant of 1862,	$7,300 00	–	
Hatch fund of 1887,	15,000 00	–	
Morrill fund of 1890,	16,666 67	–	
Adams fund of 1906,	15,000 00	–	
Nelson fund of 1907,	16,666 66	–	
Smith-Lever fund of 1914,	31,247 93	–	
Short Course, unit,	8,160 00	–	
Short Course, two years,	12,500 00	–	
November, September and October schedules in transit.	–	$116,185 56	116,185 56
	$156,296 79	$1,036,739 76	$1,193,036 55
Payments.			
College expenses,			$567,240 59
Personal services,	$40,055 13	$298,075 47	
Maintenance,	37 90	229,072 09	
Experiment Station,			90,340 53
Personal services,	29,760 24	43,060 36	
Maintenance,	216 22	17,303 71	
Extension Services,			113,811 81
Personal services,	26,531 51	48,371 91	
Maintenance,	2,491 84	36,416 55	
Short Courses,			55,131 17
Personal services,	15,979 84	27,306 65	
Maintenance,	3,904 12	7,940 56	
Market-Garden Field Station,			7,957 50
Personal services,	–	5,277 29	
Maintenance,	–	2,680 21	
Trustees, travels,	–	798 39	798 39
Printing reports,	–	1,641 27	1,641 27
Commercial feedstuffs,	–	5,767 91	5,767 91
Fertilizer law,	–	12,410 84	12,410 84
Poultry disease law,	–	3,064 98	3,064 98
Milk testing law,	–	525 08	525 08
Special appropriations,			145,824 67
1917, improvements power plant,	–	32 25	
1918, Market-Garden Field Station,	–	3,426 61	
1918, dining hall,	–	312 40	
1919, improvements and equipments,	–	9,541 74	
1919, women's dormitory,	–	100,219 74	
1919, Market-Garden Field Station,	–	5,056 22	
1919, Engineering survey,	–	1,104 91	
1920, Improvements and equipments,	–	24,847 41	
1920, Cavalry barn,	–	1,283 39	
Income,	–	151,201 82	151,201 82
Balance,	37,319 99	–	37,319 99
	$156,296 79	$1,036,739 76	$1,193,036 55

CLASSIFICATION OF INCOME FROM STUDENTS AND OTHERS.

	Laboratory Department Fees.	Sales.	Rent.	Miscellaneous.	Tuition.	Totals.
Agronomy,	$212 50	–	–	$0 45	–	$212 95
Animal husbandry,	342 00	–	–	–	–	342 00
Beekeeping,	–	$145 85	–	–	–	145 85
Botany,	497 00	–	–	–	–	497 00
Chemistry,	2,491 39	8 30	–	–	–	2,499 69
Dairying,	321 00	29,484 99	–	–	–	29,805 99
Entomology,	113 00	–	$18 00	–	–	131 00
Farm,	–	41,367 75	–	232 06	–	41,599 81
Farm management,	172 50	–	–	–	–	172 50
Floriculture,	131 50	5,399 30	–	–	–	5,530 80
Forestry,	12 00	–	–	–	–	12 00
General horticulture,	–	–	–	843 26	–	843 26
Grounds,	–	–	–	22 30	–	22 30
Horticultural manufactures.	–	601 15	–	–	–	601 15
Hospital,	–	–	–	758 92	–	758 92
Landscape gardening,	386 00	–	–	–	–	386 00
Language and literature.	202 00	–	–	–	–	202 00
Library,	–	31 94	–	3 00	–	34 94
Market gardening,	59 50	3,036 75	–	–	–	3,096 25
Mathematics,	84 00	–	–	–	–	84 00
Microbiology,	282 88	–	–	257 50	–	540 38
Military,	–	–	–	12 28	–	12 28
Mount Toby,	–	585 11	–	–	–	585 11
Physics,	90 00	–	–	3 85	–	93 85
Pomology,	92 00	3,911 45	–	–	–	4,003 45
Poultry husbandry,	56 00	9,299 08	–	–	–	9,355 08
Rural engineering,	262 50	–	–	–	–	262 50
Veterinary,	24 00	–	–	1 28	–	25 28
Zoölogy and geology,	385 00	–	–	–	–	385 00
Operating and maintenance.	–	–	–	3,549 98	$3,045 00	6,594 98
General expense (cash credits).	–	–	–	1,453 61	–	1,453 61
Adams Hall,	–	–	672 00	–	–	672 00
Draper Hall,	–	–	1,221 50	–	–	1,221 50
North dormitory,	–	–	2,181 50	–	–	2,181 50
South dormitory,	–	–	1,520 00	–	–	1,520 00

CLASSIFICATION OF INCOME FROM STUDENTS AND OTHERS — *Concluded.*

	Laboratory Department Fees.	Sales.	Rent.	Miscellaneous.	Tuition.	Totals.
College residences, .	–	–	$571 56	–	–	$571 56
President's office, .	–	–	–	$25 29	–	25 29
Registrar's office, .	–	–	–	15	–	15
Treasurer's office, .	–	–	–	76 08	–	76 08
Totals, . . .	$6,216 77	$93,871 67	$6,184 56	$7,240 01	$3,045 00	$116,558 01
Less refunds, . .	–	8 26	–	3 00	–	11 26
Totals, . . .	$6,216 77	$93,863 41	$6,184 56	$7,237 01	$3,045 00	$116,546 75

ANALYSIS OF COLLEGE EXPENDITURES.

ADMINISTRATION.	Office Expense.	Salaries and Labor.	Travel.	Minor Equipment.	Building Supplies.	Publicity and Lectures.	Student Activities.	Commencement.	Miscellaneous.	Totals.
Dean's office,	$341 14	$258 63	-	$3 68	-	-	-	-	-	$603 45
Executive order,	-	-	$2,458 96	-	-	$2,833 66	$228 26	$1,060 47	$4,260 27	10,841 62
President's office,	1,928 72	122 63	205 90	29 16	$11 95	-	-	-	25 64	2,324 00
Registrar's office,	647 60	75 90	70 20	4 13	-	-	-	-	-	797 83
Treasurer's office,	900 32	614 39	179 04	125 73	54 77	-	-	-	69 41	1,943 66
Administration (salaries),	-	38,082 71	-	-	-	-	-	-	-	38,082 71
Totals,	$3,817 78	$39,154 26	$2,914 10	$162 70	$66 72	$2,833 66	$228 26	$1,060 47	$4,355 32	$54,593 27

MAINTENANCE.	Office Expense.	Labor.	Laboratory Supplies.	Minor Equipment.	Building Supplies.	Travel.	General Expense.	Miscellaneous.	Salaries.	Totals.
Academic maintenance: —										
Agricultural economics,	$181 86	$95 82	$35 03	$65 11	$6 33	$124 48	-	-	-	$508 63
Agricultural education,	204 97	-	41 53	57 33	-	76 74	-	$81 09	-	461 66
Agronomy,	192 56	261 00	418 78	155 29	-	125 11	-	-	-	1,152 74
Animal husbandry,	254 72	180 10	28 02	26 87	-	211 32	-	-	-	701 03
Beekeeping,	-	473 60	2 65	3 59	2 73	-	-	-	-	482 57
Botany,	212 65	663 86	620 68	3 00	95 16	21 67	-	-	-	1,617 02

ANALYSIS OF COLLEGE EXPENDITURES — *Concluded.*

MAINTENANCE.	Office Expense.	Labor.	Laboratory Supplies.	Minor Equipment.	Building Supplies.	Travel.	General Expense.	Miscellaneous.	Salaries.	Totals.
Chemistry,	$131 46	$1,031 59	$3,735 65	$46 51	$76 71	$8 90	-	-	-	$5,030 82
Dairying,	293 75	4,681 48	33,319 80	413 61	391 68	63 90	-	$0 52	-	39,164 74
Domestic science,	477 70	240 83	741 63	56 64	12 30	293 85	-	-	-	1,822 95
Economics and sociology,	26 97	14 75	-	-	10 81	-	-	18 90	-	71 43
Entomology,	104 54	301 85	54 66	45 60	98 49	-	-	-	-	605 14
Farm management,	176 34	124 73	86 01	88 28	-	113 40	-	-	-	588 76
Floriculture,	79 76	5,801 98	999 88	91 61	29 04	15 28	-	7 00	-	7,024 55
Forestry,	25 99	81 00	7 40	11 34	4 98	33 33	-	1 04	-	165 08
General agriculture,	-	1,844 14	-	223 76	258 41	-	-	71 77	-	2,398 08
Horticultural manufactures,	79 86	1,240 73	1,805 91	148 94	-	25 92	-	10 00	-	3,311 36
Hospital,	-	1,760 82	-	20 60	-	-	$1,339 86	-	-	3,121 28
Landscape gardening,	62 84	4 80	347 91	-	-	25 09	-	38 78	-	479 42
Language and literature,	10 08	80 39	80 11	124 80	-	30 28	-	30 00	-	355 66
Market gardening,	156 00	4,203 03	1,296 87	35 71	36 47	255 14	-	35 00	-	6,018 22
Mathematics,	73 75	105 27	6 43	1 73	13 18	-	-	-	-	200 36
Microbiology,	96 04	595 77	594 37	121 96	40 13	-	-	-	-	1,448 27
Military science,	173 44	446 95	43	411 05	100 84	-	124 24	39 88	-	1,296 83
Mount Toby,	-	327 91	-	9 83	-	13 04	-	42 70	-	393 48
Physical education,	113 60	490 39	164 24	-	30 08	327 41	-	-	-	1,125 72
Physics,	9 80	369 10	246 03	24 25	12 43	-	-	-	-	661 61
Pomology,	281 54	4,858 07	685 91	66 43	-	44 93	-	5 00	-	5,941 88

Poultry husbandry,	609 73	3,524 02	9,017 11	266 45	33 12	163 48	-	24 26	-	13,638 17
Rural engineering,	85 78	48 46	255 63	153 69	55 34	20 24	-	19 97	-	639 11
Rural sociology,	70 45	15 00	-	50	2 40	-	-	-	-	88 35
Veterinary,	40 56	193 17	1,098 87	60 05	38 44	25 18	-	-	-	1,456 27
Zoölogy and geology,	11 94	314 15	216 55	3 25	21 10	25 80	-	-	-	592 79
General maintenance: —										
Farm,	-	-	-	-	-	-	61,369 34	-	-	61,369 34
General horticulture,	361 23	4,111 92	-	1,085 17	-	22 16	2,827 78	334 17	-	8,742 43
Graduate School,	51 40	-	-	-	-	-	-	-	-	51 40
Grounds,	-	6,722 46	-	473 48	-	11 12	87 22	191 79	-	7,486 07
Library,	534 54	863 67	-	70 29	-	128 85	6,103 32	-	-	7,700 67
General expense,	-	-	-	-	-	-	1,453 61	-	-	1,453 61
Operating and maintenance,	-	-	-	-	-	-	130,943 01	-	-	130,943 01
Totals,	$5,185 85	$46,072 81	$55,908 09	$4,366 72	$1,370 17	$2,206 62	$204,248 38	$951 87	-	$320,310 51
Instruction (salaries),	-	-	-	-	-	-	-	-	$149,319 85	149,319 85
Morrill fund,	-	-	-	-	-	-	-	-	16,371 24	16,371 24
Nelson fund,	-	-	-	-	-	-	-	-	16,371 26	16,371 26
Endowment fund,	-	-	-	-	-	-	-	37 90	7,312 63	7,350 53
Income to State Treasurer,	-	-	-	-	-	-	-	-	-	116,546 75
	-	-	-	-	-	-	-	-	-	$626,270 14
Administration,	-	-	-	-	-	-	-	-	-	54,593 27
	-	-	-	-	-	-	-	-	-	$680,863 41
Less refunds,	-	-	-	-	-	-	-	-	-	11 26
Grand total,	-	-	-	-	-	-	-	-	-	$680,852 15

Current Accounts, 1920.

Disbursements and Receipts.

Accounts.	Disbursements from Nov. 30, 1919, to Nov. 30, 1920.	Receipts from Nov. 30, 1919, to Nov. 30, 1920.	Apportionment for Year ending Nov. 30, 1920.	Balance to Credit.
Administration: —				
Dean's office,	$603 45	–	$600 00	—$3 45
Executive order,	10,841 62	–	10,675 00	—166 62
President's office,	2,324 00	$25 29	1,600 00	—724 00
Registrar's office,	797 83	15	600 00	—197 83
Salaries,	38,082 71	–	38,000 00	—82 71
Treasurer's office,	1,943 66	76 08	1,300 00	—643 66
Maintenance, academic: —				
Agricultural economics,	508 63	–	550 00	41 37
Agricultural education,	461 66	–	600 00	138 34
Agronomy,	1,152 74	212 95	1,100 00	—52 74
Animal husbandry,	701 03	342 00	700 00	—1 03
Beekeeping,	482 57	145 85	1,185 00	702 43
Botany,	1,617 02	497 00	1,750 00	132 98
Chemistry,	5,030 82	2,499 69	5,200 00	169 18
Dairying,	39,164 74	29,805 99	39,850 00	685 26
Domestic science,	1,822 95	–	1,500 00	—322 95
Economics and sociology,	71 43	–	50 00	—21 43
Entomology,	605 14	131 00	815 00	209 86
Farm management,	588 76	172 50	500 00	—88 76
Floriculture,	7,024 55	5,530 80	7,550 00	525 45
Forestry,	165 08	12 00	250 00	84 92
General agriculture,	2,398 08	–	2,100 00	—298 08
Horticultural manufactures,	3,311 36	601 15	3,000 00	—311 36
Hospital,	3,121 28	758 92	2,000 00	—1,121 28
Landscape gardening,	479 42	386 00	500 00	20 58
Language and literature,	355 66	202 00	400 00	44 34
Market gardening,	6,018 22	3,096 25	6,500 00	481 78
Mathematics,	200 36	84 00	285 00	84 64
Microbiology,	1,448 27	540 38	2,100 00	651 73
Military science,	1,296 83	12 28	2,000 00	703 17
Mount Toby,	393 48	585 11	3,000 00	2,606 52
Physical education,	1,125 72	–	800 00	—325 72
Physics,	661 61	93 85	720 00	58 39
Pomology,	5,941 88	4,003 45	4,775 00	—1,166 88
Poultry husbandry,	13,638 17	9,355 08	15,500 00	1,861 83
Rural engineering,	639 11	262 50	600 00	—39 11
Rural sociology,	88 35	–	125 00	36 65
Veterinary,	1,456 27	25 28	1,300 00	—156 27
Zoölogy and geology,	592 79	385 00	575 00	—17 79
Maintenance, general: —				
Farm,	61,369 34	41,599 81	48,500 00	—12,869 34
General horticulture,	8,742 43	843 26	10,000 00	1,257 57
Graduate school,	51 40	–	100 00	48 60
Grounds,	7,486 07	22 30	7,500 00	13 93
Library,	7,700 67	34 94	6,500 00	—1,200 67
General expense,	1,453 61	1,453 61	–	–
Operating and maintenance,	130,943 01	12,761 54	104,000 00	—26,943 01
Endowment fund,	7,350 53	10,613 32	10,613 32	6,655 35
Instruction: —				
Salaries,	149,319 85	–	159,000 00	9,680 15
United States Treasurer, Morrill fund,	16,371 24	16,666 67	16,666 67	10,088 90
United States Treasurer, Nelson fund,	16,371 26	16,666 66	16,666 66	10,088 88
State Treasurer, account of schedules,	–	527,147 56*	–	–
Income to State Treasurer,	116,546 75	–	–	–
	$680,863 41	$687,652 22	$540,201 65	$318 11
*Less amount transferred from Experiment Station,	–	2,935 19*	–	–
	$680,863 41	$684,717 03	–	–
Less refunds,	11 26	11 26	–	–
	$680,852 15	$684,705 77	–	–
Balance beginning fiscal year Dec. 1, 1919,	–	22,979 51	–	–
Balance on hand Nov. 30, 1920,	26,833 13	–	–	–
	$707,685 28	$707,685 28	–	–

College Accounts.

Comparative Disbursements and Receipts for 1919–20.

Accounts.	Disbursements.		Receipts.	
	1919.	1920.	1919.	1920.
Agricultural economics,	$377 98	$508 63	$1 22	–
Agricultural education,	264 25	461 66	10	–
Agronomy,	947 94	1,152 74	252 00	$212 95
Animal husbandry,	742 75	701 03	294 20	342 00
Beekeeping,	–	482 57	–	145 85
Botany,	1,482 78	1,617 02	627 76	497 00
Chemistry,	4,636 62	5,030 82	2,669 42	2,499 69
Dairying,	33,550 70	39,164 74	33,301 94	29,805 99
Dean's office,	522 50	603 45	55	–
Domestic science,	2,397 27	1,822 95	.68	–
Economics and sociology,	65 78	71 43	–	–
Entomology,	943 87	605 14	1,082 50	131 00
Executive order,	7,085 23	10,841 62	–	–
Farm,	50,997 36	61,369 34	44,238 47	41,599 81
Farm management,	358 32	588 76	195 60	172 50
Floriculture,	7,468 40	7,024 55	4,549 99	5,530 80
Forestry,	337 79	165 08	9 00	12 00
Freshman agriculture,	188 60	–	219 00	–
General agriculture,	2,001 15	2,398 08	4 15	–
Graduate school,	60 26	51 40	–	–
General horticulture,	9,117 97	8,742 43	2,248 26	342 26
Grounds,	5,731 00	7,486 07	107 13	22 30
Horticultural manufactures,	3,429 13	3,311 36	641 03	601 15
Hospitals,	2,212 25	3,121 28	792 48	758 92
Landscape gardening,	169 44	479 42	248 24	386 00
Language and literature,	210 06	355 66	170 00	202 00
Library,	6,919 64	7,700 67	59 34	34 94
Market gardening,	7,892 42	6,018 22	4,804 51	3,096 25
Mathematics,	220 86	200 36	232 81	84 00
Military,	1,387 77	1,296 83	–	12 28
Microbiology,	1,825 90	1,448 27	704 60	540 38
Mount Toby,	3,372 34	393 48	5,872 15	585 11
Physical education,	841 27	1,125 72	–	–
Physics,	722 24	661 61	40 05	93 85
Pomology,	4,550 18	5,941 88	3,738 61	4,003 45
Poultry husbandry,	16,248 47	13,638 17	15,895 74	9,355 08
President's office,	1,971 58	2,324 00	3 50	25 29
Registrar's office,	600 58	797 83	25	15
Rural engineering,	742 47	639 11	214 14	262 50
Rural sociology,	174 96	88 35	–	–
Salaries,	153,261 35	187,402 56	–	–
Treasurer's office,	1,540 22	1,943 66	64 55	76 08
Veterinary science,	895 21	1,456 27	6 00	25 28
War emergency,	102 62	–	844 62	–
Zoölogy and geology,	655 34	592 79	516 13	385 00
General expense,	31,350 07	1,453 61	31,350 07	1,453 61
Operating and maintenance,	98,123 29	130,948 01	13,527 63	12,761 54
State Treasurer: —				
Endowment fund,	7,220 76	7,350 53	10,613 32	10,613 32
Graduate school,	–	–	–	–
Maintenance,	–	–	–	–
Instruction,	–	–	–	–
Administration,	–	–	–	–
United States Treasurer: —				
Morrill fund,	16,777 42	16,371 24	16,848 67	16,666 67
Nelson fund,	16,777 40	16,371 26	16,848 66	16,666 66
State Treasurer account of schedules,	–	–	427,244 04	527,147 56
Income to State Treasurer,	128,673 20	116,546 75	–	–
	$638,146 96	$680,863 41	$641,083 11	$687,652 22
Less journal entries and refunds,	41,454 14	11 26	40,855 22	11 26
	$596,692 82	$680,852 15	$600,227 89	$687,640 96
Less amount transferred from Experiment Station,	–	–	–	2,935 19
	$596,692 82	$680,852 15	$600,227 89	$684,705 77
Balance beginning of fiscal year,	–	–	19,444 44	22,979 51
Balance on hand at close of fiscal year,	22,979 51	26,833 13	–	–
	$619,672 33	$707,685 28	$619,672 33	$707,685 28

COLLEGE ACCOUNTS — *Concluded.*

Summary.

	Disbursements.	Receipts.
Cash on hand Dec. 1, 1919,	–	$22,979 51
Institution receipts Nov. 30, 1920,	–	116,546 75
State Treasurer's receipts Nov. 30, 1920,	–	524,212 37[1]
United States Treasurer's receipts Nov. 30, 1920,	–	33,333 33
State Treasurer, endowment fund,	–	10,613 32
Total disbursements,	$564,305 40	–
Receipts turned in to State Treasurer,	116,546 75	–
	$680,852 15	$707,685 28
Bills receivable Dec. 1, 1919, deducted,	–	8,206 00
Bills payable Dec. 1, 1919, deducted,	7,179 90	–
	$673,672 25	$699,479 28
Bills receivable Nov. 30, 1920,	–	8,773 84
Bills payable Nov. 30, 1920,	1,785 17	–
Balance,	32,755 70	–
	$708,213 12	$708,213 12

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[1] Less amount transferred from Experiment Station, $2,935.19.

FARM DISBURSEMENTS.

	Labor.	Equipment.	Feed.	Supplies.	Sundry.	Bedding.	Fertilizer.	Seeds.	Improvements.	Totals.
Dairy cattle,	$10,352 47	$1,415 06	$2,890 94	$3,108 62	$916 01	–	–	–	–	$18,683 10
Sheep,	1,405 81	239 21	–	7 80	201 73	–	–	–	–	1,864 55
Horses,	1,599 46	117 89	11 30	48 79	309 57	–	–	–	–	2,087 01
Live stock,	419 36	–	16,383 66	–	–	$1,941 88	–	–	–	18,744 90
Swine,	1,238 09	91 13	1,838 39	5 90	68 17	–	–	–	–	3,241 68
Field crops,	6,167 22	–	–	46 73	–	–	$1,224 73	$489 47	–	7,928 15
Tools and machinery,	501 06	1,090 81	–	492 53	–	–	–	–	–	2,084 40
Miscellaneous,	3,962 40	–	–	293 03	112 85	–	–	–	$2,367 27	6,735 55
Totals,	$25,645 87	$2,954 10	$21,124 29	$4,013 40	$1,608 33	$1,941 88	$1,224 73	$489 47	$2,367 27	$61,369 34

FARM CREDITS.

	Milk.	Stock.	Sundry.	Labor.	Field Crops.	Tools and Machinery.	Improvements.	Totals.
Dairy cattle,	$32,210 77	$2,783 07	$41 70	–	–	–	–	$35,035 54
Horses,	–	–	35 00	$81 41	–	–	–	116 41
Sheep,	–	185 00	152 00	–	–	–	–	337 00
Live stock,	–	–	22 00	–	–	–	–	22 00
Swine,	–	2,081 88	–	–	–	–	–	2,081 88
Field crops,	–	–	–	–	$3,762 33	–	–	3,762 33
Tools and machinery,	–	–	–	–	–	$12 00	–	12 00
Miscellaneous,	–	–	–	150 65	–	–	$82 00	232 65
Totals,	$32,210 77	$5,049 95	$250 70	$232 06	$3,762 33	$12 00	$82 00	$41,599 81

AGRICULTURAL DIVISION.

Disbursements and Receipts.

	Disbursements.	Receipts.
Agronomy,	$1,152 74	$212 95
Animal husbandry,	701 03	342 00
Dairying,	39,164 74	29,805 99
Farm,	61,369 34	41,599 81
Farm management,	588 76	172 50
Poultry husbandry,	13,638 17	9,355 08
Rural engineering,	639 11	262 50
Division totals,	$117,253 89	$81,750 83

Summary.

	Dr.	Cr.
By total division receipts,		$81,750 83
By bills receivable,		6,958 87
By net apportionment,		24,999 17
To total disbursements,	$117,253 89	
To bills payable,	591 31	
Balance,		4,136 33
	$117,845 20	$117,845 20

Inventory of Quick Assets.

	Nov. 30, 1919.	Nov. 30, 1920.
Inventory of produce,	$14,967 85	$13,663 93
Inventory of cattle,	17,090 00	17,850 00
Inventory of swine,	1,507 00	1,171 00
Inventory of horses,	4,350 00	3,650 00
Inventory of poultry,	2,946 10	2,467 50
Inventory of sheep,	2,010 00	2,885 00
	$42,870 95	$41,687 43

HORTICULTURAL DIVISION.

Disbursements and Receipts.

	Disbursements.	Receipts.
Floriculture,	$7,024 55	$5,530 80
General horticulture,	8,742 43	843 26
Forestry,	165 08	12 00
Grounds,	7,486 07	22 30
Horticultural manufactures,	3,311 36	601 15
Landscape gardening,	479 42	386 00
Market gardening,	6,018 22	3,096 25
Pomology,	5,941 88	4,003 45
Mount Toby,	393 48	585 11
Division totals,	$39,562 49	$15,080 32

Summary.

	Dr.	Cr.
By total division receipts,		$15,080 32
By bills receivable,		1,496 62
By net apportionment,		27,994 68
To total division disbursements,	$39,562 49	
To bills payable,	33 34	
By balance,	4,975 79	
	$44,571 62	$44,571 62

Inventory of Quick Assets.

	Nov. 30, 1919.	Nov. 30, 1920.
Floriculture,	$1,200 00	$1,500 00
General horticulture (live stock),	1,995 00	1,855 00
Horticultural manufactures,	200 00	150 00
Market gardening,	175 50	85 00
Mount Toby,	4,790 22	4,050 00
Pomology,	455 00	1,350 00
	$8,815 72	$8,990 00

EXPENSE OPERATING AND MAINTENANCE.

	Salaries and Labor.	Fuel and Water.	Repairs.	Equipment.	Miscellaneous.	Totals.
General: —						
General superintendent,	$2,974 00	–	–	–	–	$2,974 00
Office,	1,251 17	–	–	–	$824 16	2,075 33
General expense,	1,855 54	–	$1,742 24	–	–	3,597 78
Power plant: —						
Heat,	13,906 55	$65,793 74	2,381 27	–	–	82,081 56
Light,	5,709 39	–	1,238 93	–	–	6,948 32
Tools,	–	–	–	$953 56	–	953 56
Amherst Water Company,	–	2,717 90	–	–	–	2,717 90
Night watchman,	1,999 52	–	–	–	–	1,999 52
Mail service,	270 59	–	–	–	–	270 59
Water mains,	281 53	–	–	–	–	281 53
Steam mains,	1,590 96	–	–	–	–	1,590 96
Electric light circuit,	2,102 93	–	–	–	–	2,102 93
Freight and express,	–	–	–	–	1,383 59	1,383 59
Telephone,	–	–	–	–	1,615 69	1,615 69
Truck,	–	–	459 09	–	–	459 09
Miscellaneous sundry,	31 41	–	–	–	450 24	481 65
Sewers and cesspools,	96 52	–	–	–	–	96 52
Walks and drives,	22 90	–	–	–	–	22 90
Emergency maintenance,	1,759 92	–	365 64	284 73	487 83	2,898 12
Expert service: —						
Architect,	714 10	–	–	–	–	714 10
Engineer,	161 25	–	–	–	–	161 25
Fire department,	10 75	–	–	106 77	8 16	125 68
Totals,	$34,739 03	$68,511 64	$6,187 17	$1,345 06	$4,769 67	$115,552 57

EXPENSE OPERATING AND MAINTENANCE — *Continued.*

	Electric Repairs.	Plumbing Repairs.	Heat Repairs.	C. and M. Repairs.	Janitor.	Sundry.	Totals.
College buildings: —							
Adams Hall,	$3 69	–	–	–	–	$278 43	$282 12
Animal husbandry building,	–	$25 64	$2 30	$5 99	–	–	33 93
Apiary building,	1 00	8 91	1 73	1 50	–	–	13 14
Chemical building,	21 17	81 80	58 28	124 53	–	–	285 78
Clark Hall,	1 46	85 33	10 53	155 23	–	–	252 55
Cold-storage building,	–	–	–	42 00	–	–	42 00
Dairy building,	17 22	174 08	596 84	303 93	–	–	1,092 07
Dairy barn and storage,	78 30	201 59	10 45	202 05	–	–	492 39
Draper Hall,	83 85	179 72	85 43	959 39	–	1,014 05	2,322 44
Drill Hall,	2 80	354 37	33 09	125 16	–	–	515 42
Durfee glass house (old),	–	–	33 48	–	–	–	33 48
Durfee glass house (new),	–	–	118 75	18 35	–	–	137 10
Entomology building,	3 92	84 15	23 97	261 27	–	–	373 31
French Hall,	77 86	34 04	122 78	112 20	–	–	346 88
Horse barn,	1 28	81 17	3 88	39 23	–	–	125 56
Horticultural barn,	26 55	4 13	–	95 38	–	–	126 06
Hospital,	23 36	30 36	–	182 07	–	–	235 79
Machine barn,	–	74 82	–	68 13	–	–	142 95
Mathematics building,	3 50	–	3 84	204 54	–	–	211 88
Microbiology building,	20 10	54 93	5 38	51 83	–	–	132 24
Physics building,	–	5 17	12 41	8 68	–	–	26 26
Piggery,	–	30	–	64	–	–	94
Poultry No. 1,	96	8 15	1 15	51 36	–	–	61 62
Poultry No. 2,	1 65	3 30	–	1 20	–	–	6 15
Poultry No. 4,	4 62	–	–	27 38	–	–	32 00
Poultry No. 5,	–	–	–	96 96	–	–	96 96
Power building,	128 88	207 14	91 55	360 29	$369 70	–	1,157 56
Rural engineering building,	4 92	–	–	53 13	–	–	58 05
Stockbridge Hall,	41 13	35 52	50 71	168 41	–	–	295 77
Agronomy greenhouse,	–	48	–	–	–	–	48
Turbine house,	600 69	74 49	16 90	219 42	–	23 67	935 17
Upper plant house,	5 73	60 69	38 97	97	–	–	106 36
Veterinary building,	07	10 19	6 26	3 86	–	–	20 38

EXPENSE OPERATING AND MAINTENANCE — *Concluded.*

	Electric Repairs.	Plumbing Repairs.	Heat Repairs.	C. and M. Repairs.	Janitor.	Sundry.	Totals.
Waiting station,	-	-	-	$3 55	-	-	$3 55
Wilder Hall,	$50 09	$26 87	$22 29	6 98	-	-	106 23
Young stock barn,	2 10	23 72	-	30 93	-	-	56 75
East Experiment Station,	-	58 74	-	12 06	-	-	70 80
East Experiment Station barn,	-	8 67	-	6 09	-	-	14 76
West Experiment Station,	2 20	27 09	15 31	58 72	-	-	103 32
West Experiment Station barn,	52	4 03	12 15	141 12	-	-	157 82
North College,	138 14	24 65	55	168 67	$659 74	$165 25	1,157 00
South College,	121 91	113 95	11 21	546 44	659 76	157 25	1,610 52
Chapel,	52 98	25 93	16 34	114 78	301 08	-	511 11
Bell ringer,	-	-	-	-	-	95 99	95 99
Cashier's house,	-	21 87	-	7 28	-	-	29 15
Farm bungalow,	7 97	38 29	13 32	10 15	-	-	69 73
Farmhouse No. 1,	6 87	130 22	25 50	162 59	-	-	325 18
Farmhouse No. 2,	11 85	11 40	-	21 21	-	-	44 46
Goldberg house,	2 19	10 40	-	94 22	-	-	106 81
Harlow house,	-	48 04	-	530 73	-	-	578 77
Head of Division of Horticulture,	1 73	40	1 85	30 51	-	-	34 49
Kellogg house,	1 00	4 22	3 33	8 31	-	28 96	45 82
President's house,	17 70	49 53	14 44	116 30	-	10 12	208 09
Stockbridge house,	-	6 63	-	43 70	-	-	50 33
Tillson house,	-	14 79	-	18	-	-	14 97
Totals,	$1,571 96	$2,529 91	$1,464 97	$6,059 60	$1,990 28	$1,773 72	$15,390 44

Summary.

General,	$115,552 57
College buildings,	13,882 64
College residences,	1,507 80
Totals,	$130,943 01

EXPERIMENT STATION.

Disbursements and Receipts.

	Disbursements from Dec. 1, 1919, to Nov. 30, 1920.	Receipts from Dec. 1, 1919, to Nov. 30, 1920.	Apportionment for Year ending Nov. 30, 1920.	Balance to Credit.
Administration,	$943 03	$1 35	$1,100 00	$156 97
Agricultural,	8,747 21	1,689 80	9,500 00	752 79
Agricultural economics,	434 66	–	600 00	165 34
Botanical,	2,046 51	–	2,100 00	53 49
Chemical,	3,879 58	2,432 80	5,000 00	1,120 42
Cranberry,	5,874 74	3,912 35	4,000 00	—1,874 74
Entomological,	514 56	–	700 00	185 44
Freight and express,	197 52	–	400 00	202 48
Horticultural,	2,329 82	16 20	2,000 00	—329 82
Library,	524 66	–	500 00	—24 66
Meteorology,	364 58	–	400 00	35 42
Microbiology,	848 38	–	1,400 00	551 62
Poultry,	2,690 18	–	2,700 00	9 82
Publications,	2,552 05	–	2,725 00	172 95
Salaries,	60,444 48	–	51,775 00	—8,669 48
Treasurer's office,	359 41	–	400 00	40 59
Veterinary,	532 04	–	700 00	167 96
Hatch fund,	–	15,000 00	–	–
Adams fund,	–	15,000 00	–	–
Transferred to general maintenance,	–	2,935 19	–	–
State Treasurer, account of schedules,	–	60,364 07	–	–
Income remitted to State Treasurer,	8,044 81	–	–	–
	$101,328 22	$101,351 76	$86,000 00	—$7,283 41
Less refunds,	7 69	7 69	–	–
	$101,320 53	$101,344 07	–	–
Balance beginning fiscal year Dec. 1, 1919.	–	2,838 98	–	–
Balance on hand Nov. 30, 1920,	2,862 52	–	–	–
Totals,	$104,183 05	$104,183 05	–	–

EXPERIMENT STATION — *Continued.*

Comparative Disbursements and Receipts, 1919–20.

ACCOUNTS.	DISBURSEMENTS.		RECEIPTS.	
	1919.	1920.	1919.	1920.
Administration,	$835 87	$943 03	$1 00	$1 35
Agriculture,	9,205 27	8,747 21	4,908 59	1,689 80
Agricultural economics,	699 16	434 66	–	–
Botanical,	1,967 65	2,046 51	–	–
Chemical,	4,991 27	3,879 58	3,820 67	2,432 80
Cranberry,	3,618 41	5,874 74	4,234 46	3,912 35
Entomological,	605 48	514 56	4 55	–
Freight and express,	353 38	197 52	–	–
Horticultural,	1,603 09	2,329 82	100 25	16 20
Library,	742 17	524 66	–	–
Meteorology,	321 96	364 58	–	–
Microbiology,	1,258 22	848 38	–	–
Poultry,	2,355 95	2,690 18	32 70	–
Publication,	1,374 62	2,552 05	–	–
Salaries,	50,753 50	60,444 48	–	–
Tillson farm,	2,340 73	–	1,259 91	–
Treasurer's office,	341 37	359 41	–	–
Veterinary,	813 66	532 04	148 54	–
Hatch fund,	–	–	15,000 00	15,000 00
Adams fund,	–	–	15,000 00	15,000 00
Transferred to general maintenance,	–	–	–	2,935 19
State Treasurer, account of schedules,	–	–	48,728 05	60,364 07
Income remitted to State Treasurer,	8,752 05	8,044 81	–	–
	$92,933 81	$101,328 22	$93,238 72	$101,351 76
Less refunds,	–	7 69	–	7 69
	$92,933 81	$101,320 53	$93,238 72	$101,344 07
Balance beginning of fiscal year,	–	–	2,534 07	2,838 98
Balance on hand at close of fiscal year,	2,838 98	2,862 52	–	–
Totals,	$95,772 79	$104,183 05	$95,772 79	$104,183 05

EXPERIMENT STATION — *Concluded.*

Analysis of Experiment Station Accounts.

	Adams Fund.	Hatch Fund.	State Fund.	Totals.
Salaries,	$14,251 65	$14,318 09	$31,874 74	$60,444 48
Labor,	272 00	918 50	14,120 81	15,311 31
Publications,	–	–	2,568 34	2,568 34
Postage and stationery,	–	–	1,351 79	1,351 79
Freight and express,	–	–	239 75	239 75
Heat, light, water and power,	–	–	431 29	431 29
Chemical and laboratory supplies,	–	–	1,211 26	1,211 26
Seeds, plants and sundry supplies,	–	–	2,881 32	2,881 32
Fertilizers,	216 22	–	950 45	1,166 67
Feedstuffs,	–	–	790 14	790 14
Library,	–	–	616 14	616 14
Tools, machinery and appliances,	–	–	1,282 25	1,282 25
Furniture and fixtures,	–	–	105 35	105 35
Scientific apparatus and specimens,	–	–	344 28	344 28
Live stock,	–	–	1,078 00	1,078 00
Traveling expenses,	–	–	1,962 75	1,962 75
Contingent expenses,	–	–	62 65	62 65
Buildings and land,	–	–	1,435 64	1,435 64
Totals,	$14,739 87	$15,236 59	$63,306 95	$93,283 41

Summary.

	Disbursements.	Receipts.
Cash on hand Dec. 1, 1919,	–	$2,838 98
Receipts from State Treasurer,	–	63,299 26
Receipts from United States Treasurer,	–	30,000 00
Receipts from other sources,	–	8,044 81
Total disbursements,	$93,275 72[1]	–
Receipts turned in to State Treasurer,	8,044 81	–
	$101,320 53	$104,182 05
Bills receivable Dec. 1, 1919, deducted,	–	770 44
Bills payable Dec. 1, 1919, deducted,	954 14	–
	$100,366 39	$103,411 61
Bills receivable Nov. 30, 1920,	–	640 87
Bills payable Nov. 30, 1920,	169 19	–
Balance,	3,516 90	–
	$104,052 48	$104,052 48

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[1] Includes amount transferred to general maintenance, $2,935.19.

EXTENSION SERVICE.[1]

Disbursements and Receipts.

CLASSIFICATION.	Disbursements.	Receipts.	Apportionment.	Balance.
Administration,	$4,321 37	$62 71	$4,000 00	—$321 37
Animal husbandry,	787 49	–	1,200 00	412 51
Co-operative marketing,	1,478 98	–	1,500 00	21 02
Correspondence Courses,	1,592 61	643 00	800 00	—792 61
County agents' work,	1,726 87	–	1,800 00	73 13
Dairying,	1,584 42	–	1,800 00	215 58
Director's office,	82 52	33 09	2,700 00	2,617 48
Emergency,	–	–	2,000 00	2,000 00
Exhibits,	3,649 04	–	5,000 00	1,350 96
Extension courses at College,	1,318 55	–	3,000 00	1,681 45
Extension schools,	488 03	28 75	250 00	—238 03
Farm management demonstration,	1,202 67	123 53	1,000 00	—202 67
Home demonstration agents,	5,901 85	173 14	4,500 00	—1,401 85
Home economics specialists,	29 23	–	–	—29 23
Home gardening,	760 24	–	300 00	—460 24
Horticultural manufactures,	1,946 67	–	1,600 00	—346 67
Injurious insects,	46 46	–	100 00	53 54
Junior Extension work,	5,241 03	–	3,500 00	—1,741 03
Landscape extension,	93 55	–	50 00	—43 55
Lectures,	51 56	–	100 00	48 44
Library extension,	317 98	–	400 00	82 02
Local community organization,	–	–	100 00	100 00
Methods of Extension instruction,	162 78	–	600 00	437 22
Plant diseases,	68 65	–	100 00	31 35
Pomology,	2,102 44	–	1,200 00	—902 44
Poultry husbandry,	1,496 96	–	1,200 00	—296 96
Printing,	2,325 74	4 00	2,600 00	274 26
Salaries,	44,409 43	1,469 17	51,000 00	6,590 57
Sheep husbandry,	550 18	–	600 00	49 82
Soils and crops,	1,051 16	–	1,000 00	—51 16
State Treasurer, account of schedules,	–	84,788 46	–	–
Income to State Treasurer,	2,537 39	–	–	–
	$87,325 85	$87,325 85	$94,000 00	$9,211 54

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[1] Includes State Smith-Lever Fund.

EXTENSION SERVICE — *Continued.*

Summary.

	Disbursements.	Receipts.
Balance Dec. 1, 1919,[1]	–	$4,623 72
Receipts Nov. 30, 1920,	–	2,537 39
Received from State Treasurer,	–	84,788 46
Received from United States Treasurer,	–	31,247 93
Disbursements to Nov. 30, 1920,[1]	$113,811 81	–
Receipts turned in to State Treasurer,	2,537 39	–
	$116,349 20	$123,197 50
Bills receivable Dec. 1, 1919, deducted,	–	88 82
Bills payable Dec. 1, 1919, deducted,	708 11	–
	$115,641 09	$123,108 68
Bills receivable Nov. 30, 1920,	–	7 50
Bills payable Nov. 30, 1920,	339 01	–
Balance,	7,136 08	–
	$123,116 18	$123,116 18

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[1] Includes Federal Smith-Lever Fund.

EXTENSION SERVICE — *Concluded.*

Analysis of Extension Service Disbursements.

	Travel.	Equipment.	Supplies.	Postage, Stationery and Small Printing.	Salaries and Labor.	Totals.
Administration,	$1,414 07	$754 36	$572 61	$1,493 34	$86 99	$4,321 37
Animal husbandry,	720 73	–	8 01	58 75	–	787 49
Co-operative marketing,	1,210 49	93 10	18 82	106 42	50 15	1,478 98
Correspondence Courses,	–	84 60	72 72	1,217 63	217 66	1,592 61
County agents' work,	998 94	124 50	71 34	456 50	75 59	1,726 87
Dairying,	1,281 75	2 00	10 65	61 87	228 15	1,584 42
Director's office,	–	65 81	22 60	10 33	—16 22	82 52
Exhibits,	915 97	316 82	1,048 20	357 39	1,010 66	3,649 04
Extension courses at College,	161 77	–	277 83	458 01	420 94	1,318 55
Extension schools,	34 80	–	62 93	287 98	102 32	488 03
Farm management demonstration.	514 57	–	55 12	342 12	290 86	1,202 67
Home demonstration agents,	3,712 26	221 25	371 33	1,091 19	505 82	5,901 85
Home economics specialists,	29 23	–	–	–	–	29 23
Home gardening,	129 49	22 15	89 53	169 42	349 65	760 24
Horticultural manufactures,	1,420 11	188 89	147 06	129 65	60 96	1,946 67
Injurious insects,	46 46	–	–	–	–	46 46
Junior Extension work,	3,588 78	36 35	937 16	656 12	22 62	5,241 03
Landscape extension,	7 70	–	43 93	1 44	40 48	93 55
Lectures,	24 06	–	–	–	27 50	51 56
Library Extension,	41 74	39 20	206 93	30 11	–	317 98
Local community organization,	–	–	–	–	–	–
Methods of Extension instruction.	53 53	–	20 07	2 25	86 93	162 78
Plant diseases,	65 40	–	2 25	1 00	–	68 65
Pomology,	1,366 40	162 27	300 58	48 86	224 33	2,102 44
Poultry husbandry,	1,325 11	15 14	47 18	66 28	43 25	1,496 96
Printing,	48 56	468 68	–	1,808 50	–	2,325 74
Salaries,	–	–	–	–	44,409 43	44,409 43
Sheep husbandry,	425 10	–	23 49	47 01	54 58	550 18
Soils and crops,	898 75	5 79	39 93	24 43	82 26	1,051 16
Totals,	$20,435 77	$2,600 91	$4,450 27	$8,926 60	$48,374 91	$84,788 46

SMITH-LEVER FUND (FEDERAL).

	Disbursements.	Receipts.
Administration,	$69 80	–
Animal husbandry,	30 00	–
Dairying,	30 00	–
Extension schools,	241 54	–
District and county agents,	57 16	–
Farm management demonstration,	30 00	–
Home demonstration agents,	407 15	–
Junior Extension,	851 22	–
Pomology,	30 00	–
Printing and publications,	714 97	–
Salaries,	26,531 51	–
Sheep husbandry,	30 00	–
State Treasurer,	–	$31,247 93
	$29,023 35	$31,247 93
Balance beginning fiscal year Dec. 1, 1919,	–	4,623 72
Balance on hand Nov. 30, 1920,	6,848 30	–
Totals,	$35,871 65	$35,871 65

SHORT COURSES.

	Personal Services.	Office.	Laboratory Supplies.	Equipment.	Travel.	Printing.	Totals.
Two-Year Course,	$16,255 58	$709 58	$4,464 22	$533 25	$335 69	–	$22,298 32
Ten Weeks' Winter School,	707 96	137 53	111 43	12 75	18 04	–	987 71
Summer School,	5,803 11	112 47	391 36	36 20	61 35	–	6,404 49
Administration,	4,540 00	–	–	11 79	–	–	4,551 79
Printing,	–	–	–	–	–	$1,004 90	1,004 90
	$27,306 65	$959 58	$4,967 01	$593 99	$415 08	$1,004 90	$35,247 21

SUMMARY.

	Dr.	Cr.
State appropriation,		$39,600 00
Amount of receipts,		4,810 25
Amount of receipts transferred to State Treasurer,	$4,810 25	
Department expenditures,	35,247 21	
Balance unexpended,	4,352 79	
	$44,410 25	$44,410 25

MARKET-GARDENING FIELD STATION.

	Debit.	Credit.
Labor,	$5,277 29	
Maintenance,	2,617 78	
Equipment,	62 43	
Total,	$7,957 50	
State appropriation,		$8,400 00
Amount of receipts,		2,286 34
Amount of receipts transferred to State Treasurer,	$2,286 34	
Department expenditures,	7,957 50	
Balance unexpended,	442 50	
	$10,686 34	$10,686 34

SPECIAL APPROPRIATIONS.

	Date made.	Appropriation.	Amount expended to Date.	Unexpended Balance.
Power plant improvements,	1917	$40,000 00	$39,988 16	$11 84
Market-Garden Field Station,	1918	16,500 00	16,496 14	3 86
Dining hall,	1918	12,000 00	11,988 81	11 19
Improvements and equipment,	1919	20,000 00	19,985 48	14 52
Women's dormitory,	1919	127,400 00	106,235 81	21,164 19
Market-Garden Field Station,	1919	15,000 00	9,404 95	5,595 05
Engineering studies,	1919	2,000 00	1,937 18	62 82
Improvements and equipment,	1920	50,000 00	24,847 41	25,152 59
Cavalry barn,	1920	15,000 00	1,283 39	13,716 61
	–	$297,900 00	$232,167 33	$65,732 67
Amount spent previous to Dec. 1, 1919,	–	–	–	86,342 66
Amount expended during fiscal year,	–	–	–	145,824 67
Unexpended balance Nov. 30, 1920,	–	–	65,732 67	–
	–	$297,900 00	$297,900 00	$297,900 00

INVENTORY — REAL ESTATE.

Land (Estimated Value).

Angus land,	$800 00
Allen place,	500 00
Baker place,	2,500 00
Bangs place,	2,350 00
Brown land,	500 00
Charmbury place,	450 00
Clark place,	4,500 00
College farm,	37,000 00
Cranberry land,	12,745 00
Geo. Cutler, Jr., trustee,	2,700 00
Dickinson land,	7,850 00
Harlow farm,	1,584 63
Hawley and Brown place,	675 00
Kellogg place,	3,368 45
Loomis place,	415 00
Louisa Baker place,	5,000 00
Market-Garden Field Station,	4,800 00
Mount Toby demonstration forest,	30,000 00
Newell farm,	2,800 00
Old creamery place,	1,000 00
Owen farm,	5,000 00
Pelham quarry,	500 00
Tillson farm,	2,950 00
Westcott place,	2,250 00
Total,	$132,238 08

College Buildings (Estimated Value).

	Inventory at Beginning of Year.	Per Cent deducted.	Value at Beginning of Year less Deterioration.	Repairs and Improvements during Year.	Total Value at Close of Fiscal Year.
Animal husbandry building,	$9,211 36	2	$9,027 13	$33 93	$9,061 06
Apiary,	2,993 02	2	2,933 16	13 14	2,946 30
Cashier's house,	1,603 60	5	1,523 42	29 15	1,552 57
Chemical laboratory,	8,333 84	5	7,917 15	598 40	8,515 55
Clark Hall,	63,068 72	2	61,807 35	252 55	62,059 90
Cold-storage laboratory,	10,973 77	2	10,754 29	42 00	10,796 29
Dairy building,	70,175 79	2	68,772 27	1,092 07	69,864 34
Dairy barn and storage,	26,918 07	3	26,110 53	492 39	26,602 92
Draper Hall,	67,467 14	3	65,443 13	1,630 39	67,073 52
Drill hall and gun shed,	8,763 96	5	8,325 76	944 51	9,270 27
Durfee glass house (old),	8,157 21	5	7,749 35	33 48	7,782 83
Durfee glass house (new),	12,049 70	5	11,447 21	137 10	11,584 31
Entomology building,	73,639 10	2	72,166 32	373 31	72,539 63
Farm bungalow,	2,584 01	3	2,506 49	69 73	2,576 22
Farm house No. 1,	2,604 80	3	2,526 66	325 18	2,851 84
Farm house No. 2,	4,172 38	8	3,838 59	44 46	3,883 05
French Hall,	46,324 41	2	45,397 92	346 88	45,744 80
Grounds' tool shed,	232 75	5	221 11	–	221 11
Harlow house,	1,554 91	5	1,477 16	578 77	2,055 93
Horse barn,	4,535 04	3	4,398 99	125 56	4,524 55
Head of Division of Horticulture,	2,253 03	5	2,140 38	34 49	2,174 87
Horticultural barn,	2,469 32	3	2,395 24	1,232 68	3,627 92
Horticultural tool shed,	1,717 47	3	1,665 95	–	1,665 95
Horticultural open shed,	–	–	–	501 38	501 38
Horticultural manufactures' shed,	–	–	–	3,185 24	3,185 24
Hospital,	14,617 46	2	14,325 11	235 79	14,560 90
Kellogg house and barn,	2,568 69	5	2,440 26	803 66	3,243 92
Machinery barn,	3,471 05	3	3,366 92	142 95	3,509 87
Market-Garden Field Station barn,	3,293 15	3	3,194 36	–	3,194 36
Mathematics building,	4,933 40	5	4,686 73	211 88	4,898 61
Microbiology building,	58,937 64	2	57,758 89	132 24	57,891 13
Military storage,	237 50	5	225 62	–	225 62
Mount Toby house and barn,	3,809 67	5	3,619 19	–	3,619 19
North dormitory,	24,519 60	2	24,029 21	1,157 00	25,186 21
Physics laboratory,	4,793 40	5	4,553 73	26 26	4,579 99
Piggery,	2,592 78	3	2,515 00	94	2,515 94

College Buildings (*Estimated Value*) — Concluded.

	Inventory at Beginning of Year.	Per Cent deducted.	Value at Beginning of Year less Deterioration.	Repairs and Improvements during Year.	Total Value at Close of Fiscal Year.
Poultry department: —					
No. 1 demonstration building,	$1,330 55	2	$1,303 94	$61 62	$1,365 56
No. 2 oil house,	70 17	2	68 77	6 15	74 92
No. 3 brooder killing and fattening laboratory.	2,332 49	2	2,285 84	–	2,285 84
No. 4 mechanics, storage building and incubator cellar.	3,388 54	2	3,320 77	32 00	3,352 77
No. 5 laying house,	1,640 44	2	1,607 63	96 96	1,704 59
No. 6 manure shed,	92 84	2	90 98	–	90 98
No. 7 small henhouse,	46 72	2	45 79	–	45 79
No. 8 breeding house,	1,479 77	2	1,450 17	–	1,450 17
No. 9 experimental breeding house,	580 39	2	568 78	–	568 78
No. 10 duck house,	96 05	2	94 13	–	94 13
No. 11 unit house for 200 hens,	485 93	2	476 21	–	476 21
No. 12 unit house for 100 hens,	392 10	2	384 26	–	384 26
Power plant and storage building, including coal pocket.	48,196 70	2	47,232 77	787 86	48,020 63
President's house,	13,264 35	3	12,866 42	208 09	13,074 51
Quarantine barn,	472 30	3	458 13	–	458 13
Rural engineering building,	3,515 51	2	3,445 20	58 05	3,503 25
Sheep barn,	1,413 59	3	1,371 18	–	1,371 18
South dormitory,	37,306 65	2	36,560 52	2,010 52	38,571 04
Stockbridge Hall,	172,179 48	2	168,735 89	295 77	169,031 66
Agronomy greenhouse,	1,999 49	2	1,959 50	48	1,959 98
Stockbridge house,	1,599 54	5	1,519 56	50 33	1,569 89
Stone chapel,	27,891 96	2	27,334 12	1,373 86	28,707 98
Turbine house,	17,665 00	2	17,311 70	935 17	18,246 87
Vegetable plant house,	4,370 29	5	4,151 78	106 36	4,258 14
Veterinary laboratory and stable,	22,083 55	2	21,641 88	20 38	21,662 26
Waiting station,	466 77	2	457 43	3 55	460 98
Wilder Hall,	34,303 15	2	33,617 09	106 23	33,723 32
Young stock barns,	5,854 44	3	5,678 81	56 75	5,735 56
Totals,	$960,096 50	–	$937,299 83	$21,037 64	$958,337 47

College Equipment (Estimated Value).

Administrative division: —		
Dean's office,	$461	80
President's office,	2,485	00
Registrar's office,	1,210	70
Treasurer's office,	3,705	97
Agricultural division: —		
Agronomy,	6,553	14
Animal husbandry,	670	01
Dairy,	24,569	10
Farm,	46,950	59
Farm management,	939	46
General agriculture,	3,484	51
Poultry,	6,513	04
Rural engineering,	4,927	63
Domestic science,	2,557	69
Dining hall,	18,531	67
Extension,	15,886	31
General science: —		
Apiary,	2,235	18
Botanical,	24,329	30
Chemical,	18,088	69
Entomology,	5,208	67
Mathematics,	2,420	00
Microbiology,	7,606	88
Physics,	6,844	89
Veterinary,	10,285	25
Zoölogical and geological,	17,136	10
Graduate School,	115	80
Horticultural division: —		
Floriculture,	31,771	86
Forestry,	2,446	54
General horticulture,	7,744	65
Grounds,	1,986	38
Horticultural manufactures,	4,626	65
Landscape gardening,	5,427	66
Market-Garden Field Station,	2,298	30
Market gardening,	2,191	25
Mount Toby Reservation,	4,061	51
Pomology,	9,242	01
Hospital,	1,131	75
Humanities division: —		
Economics and sociology,	134	72
Language and literature,	678	00
Library,	114,606	38
Military,	1,410	54
Operating and maintenance: —		
College supply,	1,674	03
Fire apparatus,	2,079	60
General maintenance: —		
Carpentry and masonry supplies,	7,473	46
Electrical supplies,	4,208	75
Equipment,	17,649	20
Heating and plumbing supplies,	10,323	25

College Equipment (Estimated Value) — Concluded.

Operating and maintenance — *Con.*	
Painting supplies,	$1,497 04
Steam main,	54,750 92
Lighting lines,	8,675 80
Janitor's supplies,	1,071 52
Sewer line,	12,593 12
Water mains,	11,373 32
Physical education,	1,769 61
Rural social science: —	
Agricultural economics,	1,620 45
Agricultural education,	1,301 00
Rural sociology,	351 32
Short course,	990 11
Textbooks,	2,318 08
Trophy room,	1,200 00
Women's dormitory,	9,001 35
Total,	$575,397 51

Experiment Station Buildings (Estimated Value).

	Inventory at Beginning of Year.	Per Cent.	Cost at Beginning of Year, less Per Cent Deterioration.	Repairs and Improvements during Year.	Total Value at Close of Year.
Agricultural laboratory,	$14,224 78	2	$13,940 28	$323 82	$14,264 10
Agricultural barn,	4,448 60	3	4,315 14	14 76	4,329 90
Agricultural farmhouse,	1,417 41	3	1,374 89	106 81	1,481 70
Agricultural glass house,	386 90	5	367 55	–	367 55
Cranberry buildings,	3,412 96	5	3,242 31	–	3,242 31
Plant and animal chemistry laboratory,	28,079 50	2	27,517 91	103 32	27,621 23
Plant and animal chemistry barns,	4,081 24	3	3,958 80	157 82	4,116 62
Plant and animal chemistry dairy,	1,717 47	3	1,665 95	–	1,665 95
Six poultry houses,	562 53	2	551 28	–	551 28
Entomological glass houses,	718 24	5	682 33	–	682 33
Tillson house,	558 40	5	530 48	14 97	545 45
Tillson barn,	1,083 00	5	1,028 85	–	1,028 85
Totals,	$60,691 03	–	$59,175 77	$721 50	$59,897 27

Experiment Station Equipment (Estimated Value).

Apiary,	$158 92
Agricultural Economics Department,	183 37
Agricultural laboratory,	7,889 10
Botanical laboratory,	6,558 38
Chemical laboratory,	27,909 85
Cranberry station,	4,442 48
Director's office,	5,533 21
Entomological laboratory,	23,787 06
Horticultural laboratory,	4,976 75
Meteorological laboratory,	673 00
Microbiological laboratory,	2,380 00
Poultry Department,	4,798 65
Treasurer's office,	1,018 00
Total,	$90,308 77

Inventory Summary.

Land,	$132,238 08
College buildings,	958,337 47
College equipment,	575,397 51
Experiment Station buildings,	59,897 27
Experiment Station equipment,	90,308 77
Total,	$1,816,179 10

	Acres.
College estate (area),	642.79
Cranberry station, Wareham (area),	23.67
Market-Garden Field Station, Lexington (area),	12.00
Mount Toby demonstration forest (area),	755.27
Rifle range,	46.20
Pelham quarry,	.50
Total acreage,	1,480.43

STUDENTS' TRUST FUND ACCOUNT.

	Disbursements, Year ending Nov. 30, 1920.	Receipts, Year ending Nov. 30, 1920.	Balance on Hand.	Balance brought forward Dec. 1, 1919.
Athletics,	$16,603 61	$15,414 63	—$2,329 92	—$1,140 94
Dining hall,	94,648 47	96,514 72	—9,363 80	—11,230 05
Keys,	90 50	89 00	75 50	77 00
Students' deposits,	83,732 72	80,003 02	14,126 94	17,856 64
Social Union,	1,196 70	975 51	596 74	817 93
Textbooks,	9,825 19	9,970 64	820 08	674 63
Athletic field,	34 15	514 85	224 44	—256 26
Uniforms,	8 62	104 64	127 56	31 54
Cow testing,	17,547 55	17,591 47	359 00	315 08
Totals,	$223,687 51	$221,178 48	$4,636 54	$7,145 57
	4,636 54	7,145 57	-	-
	$228,324 05	$228,324 05	-	-

CONDENSED OPERATING STATEMENT OF THE DINING HALL.

	Operating Charges.	Income.
1919.		
Dec. 1, balance,	—$11,230 05	-
1920.		
Nov. 30, Total disbursements,	94,648 47	-
Outstanding bills,	3,001 27	-
Total collections,	-	$96,514 72
Accounts outstanding,	-	1,061 34
Inventory,	-	14,559 79
Balance,	3,256 06	-
	$112,135 85	$112,135 85

ENDOWMENT FUND.[1]

	Principal.	Income.
United States grant (5 per cent),	$219,000 00	$7,300 00
Commonwealth grant (3½ per cent),	142,000 00	3,313 32
Total,	-	$10,613 32

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[1] This fund is in the hands of the State Treasurer, and the Massachusetts Agricultural College received two-thirds of the income from the same.

BURNHAM EMERGENCY FUND.

	Market Value Dec. 1, 1920.	Par Value.	Income.
Two bonds American Telephone and Telegraph Company 4s, at $770,	$1,540 00	$2,000 00	$80 00
Two bonds Western Electric Company 5s, at $940,	1,880 00	2,000 00	100 00
One United States Liberty Bond 4¼s, at .	425 00	500 00	20 63
Puget Sound Traction, Light and Power Company 7s,	490 00	500 00	17 50
	$4,335 00	$5,000 00	$218 13
Unexpended balance Dec. 1, 1919,	–	–	580 55
	–	–	$798 68
Disbursements for fiscal year ending Nov. 30, 1920,	–	–	501 22
Cash on hand Nov. 30, 1920,	–	–	$297 46

LIBRARY FUND.

Five bonds New York Central & Hudson River Railroad Company 4s, at $700,	$3,500 00	$5,000 00	$200 00
Five bonds Lake Shore & Michigan Southern Railroad Company 4s, at $850,	4,250 00	5,000 00	200 00
Two shares New York Central & Hudson River Railroad Company stock, at $74,	148 00	200 00	10 00
Amherst Savings Bank, deposit,	167 77	167 77	8 44
	$8,065 77	$10,367 77	$418 44
Refund,	–	–	11 21
	–	–	$429 65
Disbursements for fiscal year ending Nov. 30, 1920,	–	–	429 65

SPECIAL FUNDS.

Endowed Labor Fund (the Gift of a Friend of the College).

Two bonds American Telephone and Telegraph Company 4s, at $770,	$1,540 00	$2,000 00	$80 00
Two bonds Lake Shore & Michigan Southern Railroad Company 4s, at $700,	1,400 00	2,000 00	80 00
One bond New York Central Railroad debenture 4s,	920 00	1,000 00	40 00
One bond Louisville Gas and Electric 7s,	970 00	1,000 00	70 00
Amherst Savings Bank, deposit,	143 39	143 39	7 22
One United States Liberty Bond 4¼s,	850 00	1,000 00	42 50
	$5,823 39	$7,143 39	$319 72
Unexpended balance Dec. 1, 1919,	–	–	393 75
Cash on hand Nov. 30, 1920,	–	–	$713 47

Whiting Street Scholarship Fund.

One bond New York Central debenture 4s,	$920 00	$1,000 00	$40 00
Amherst Savings Bank, deposit,	271 64	271 64	13 72
	$1,191 64	$1,271 64	$53 72
Unexpended balance Dec. 1, 1919,	–	–	395 19
Cash on hand Nov. 30, 1920,	–	–	$448 91

Special Funds — *Continued.*

Hills Fund.

	Market Value Dec. 1, 1920.	Par Value.	Income.
Two United States Liberty Bonds 4¼s, at $850,	$1,700 00	$2,000 00	$83 75
One bond American Telephone and Telegraph Company 4s, at $770,	770 00	1,000 00	40 00
One bond New York Central & Hudson River Railroad debenture 4s,	720 00	1,000 00	40 00
One bond New York Central Railroad debenture 4s,	920 00	1,000 00	40 00
Three bonds Pacific Telephone and Telegraph Company 5s, at $820,	2,460 00	3,000 00	150 00
One bond Western Electric Company 5s,	940 00	1,000 00	50 00
Amherst Savings Bank, deposit,	72 75	72 75	3 65
Boston & Albany Railroad stock, 3⅝ bonds, at $125,	453 00	362 00	31 68
Electric Securities Company bonds, 1⁹⁄₅₀ bonds, at $820,	967 60	1,180 00	59 00
Two bonds Louisville Gas and Electric 7s, at $970,	1,940 00	2,000 00	140 00
	$10,943 35	$12,614 75	$638 08
Unexpended balance Dec. 1, 1919,	–	–	914 96
	–	–	$1,553 04
Disbursements for fiscal year ending Nov. 30, 1920,	–	–	211 14
Cash on hand,	–	–	$1,341 90

Mary Robinson Fund.

Amherst Savings Bank, deposit,	$142 00	$142 00	$7 17
Boston & Albany Railroad stock, ⅜ share, at $125,	47 00	38 00	3 32
Electric Securities Company bonds, ⁴¹⁄₅₀ bond, at $820,	672 40	820 00	41 00
	$861 40	$1,000 00	$51 49
Unexpended balance Dec. 1, 1919,	–	–	290 50
Cash on hand Nov. 30, 1920,	–	–	$341 99

Grinnell Prize Fund.

Ten shares New York Central & Hudson River Railroad stock, at $74,	$740 00	$1,000 00	$50 00
Unexpended balance Dec. 1, 1919,	–	–	245 74
	$740 00	$1,000 00	$295 74
Disbursements for prizes,	–	–	50 00
Cash on hand Nov. 30, 1920,	–	–	$245 74

Gassett Scholarship Fund.

One bond New York Central & Hudson River Railroad debenture 4s,	$720 00	$1,000 00	$40 00
Amherst Savings Bank, deposit,	11 64	11 64	54
	$731 64	$1,011 64	$40 54
Unexpended balance Dec. 1, 1919,	–	–	304 19
Cash on hand Nov. 30, 1920,	–	–	$344 73

Special Funds — *Continued.*

Massachusetts Agricultural College (Investment).

	Market Value Dec. 1, 1920.	Par Value.	Income.
One share New York Central & Hudson River Railroad stock, at $74,	$74 00	$100 00	$5 00
Unexpended balance Dec. 1, 1919,	–	–	95 45
Cash on hand Nov. 30, 1920,	–	–	$100 45

Danforth Keyes Bangs Fund.

Two bonds Pacific Telephone and Telegraph Company 5s, at $820,	$1,640 00	$2,000 00	$100 00
Two bonds Union Electric and Power Company 5s, at $820,	1,640 00	2,000 00	100 00
Two bonds American Telephone and Telegraph Company 4s, at $770,	1,540 00	2,000 00	80 00
One United States Liberty Bond 4¼s,	850 00	1,000 00	42 50
Interest from students' loans,	–	–	82 84
	$5,670 00	$7,000 00	$405 34
Unexpended balance Dec. 1, 1919,	–	–	577 78
	–	–	$983 12
Total loans made to students during fiscal year, $2,539 00			
Cash received on account of students' loans, 1,964 00			
Excess of loans made over accounts paid by students,	–	–	575 00
Cash on hand Nov. 30, 1920,	–	–	$408 12

John C. Cutter Fund.

One bond Pacific Telephone and Telegraph Company 5s, at $820,	$820 00	$1,000 00	$50 00
Unexpended balance Dec. 1, 1919,	–	–	161 50
	$820 00	$1,000 00	$211 50
Disbursements for fiscal year to date,	–	–	81 71
Cash on hand Nov. 30, 1920,	–	–	$129 79

William R. Sessions Fund.

One $500 bond New York Central & Hudson River Railroad 6s,	$460 00	$500 00	$30 00
Three United States Liberty Bonds, two at $1,000 and one at $500, 4¼s, at $850,	2,125 00	2,500 00	103 12
One bond Toledo Light and Power Company 7s,	970 00	1,000 00	70 00
One bond United Electric Light Company 6s,	1,000 00	1,000 00	60 00
	$4,555 00	$5,000 00	$263 12
Earnings from exchange of bonds,	–	–	6 67
Unexpended balance Dec. 1, 1919,	–	–	50 58
	–	–	$320 37
Disbursements for fiscal year to date,	–	–	191 38
Cash on hand Nov. 30, 1920,	–	–	$128 99

SPECIAL FUNDS — *Concluded.*

Alvord Dairy Scholarship Fund.

	Market Value Dec. 1, 1920.	Par Value.	Income.
One United States Liberty Bond 4¼s,	$850 00	$1,000 00	$41 25
One bond Toledo Light and Power Company 7s,	970 00	1,000 00	70 00
Two bonds United Electric Light Company 6s, at $1,000,	2,000 00	2,000 00	120 00
	$3,820 00	$4,000 00	$231 25
Earnings from exchange of bonds,	–	–	6 67
Unexpended balance Dec. 1, 1919,	–	–	215 30
Cash on hand Nov. 30, 1920,	–	–	$453 22

SUMMARY OF BALANCE ON HAND OF THE INCOME FROM FUNDS HELD IN TRUST BY THE MASSACHUSETTS AGRICULTURAL COLLEGE.

Burnham emergency fund,	$297 46
Endowed labor fund,	713 47
Whiting Street scholarship fund,	448 91
Hills fund,	1,341 90
Mary Robinson fund,	341 99
Grinnell prize fund,	245 74
Gassett scholarship fund,	344 73
Massachusetts Agricultural College investment fund,	100 45
Danforth Keyes Bangs fund,	408 12
John C. Cutter fund,	129 79
William R. Sessions fund,	128 99
Alvord Dairy Scholarship fund,	453 22
Total,	$4,954 77

I hereby certify that I have this day examined the Massachusetts Agricultural College account, as reported by the treasurer, Fred C. Kenney, for the year ending Nov. 30, 1920. All bonds and investments are as represented in the treasurer's report. All disbursements are properly vouched for, and all cash balances are found to be correct.

CHARLES A. GLEASON,
Auditor.

JAN. 6, 1921.

HISTORY OF SPECIAL FUNDS.

Burnham emergency fund: —	
A bequest of $5,000 from T. O. H. P. Burnham of Boston made without any conditions. The trustees of the College directed that $1,000 of this fund should be used in the purchase of the Newell land and Goessmann library. The fund now shows an investment of	$4,000 00
Library fund: —	
The library of the College at the present time contains 64,765 volumes. The income from the fund raised by the alumni and others is devoted to its increase, and additions are made from time to time as the needs of the different departments require. Dec. 27, 1883, William Knowlton gave $2,000; Jan. 1, 1894, Charles L. Flint gave $1,000; in 1887, Elizur Smith of Lee, Mass., gave $1,315. These were the largest bequests, and now amount to	10,000 00
Endowed labor fund: —	
Gift of a friend of the College in 1901, income of which is to be used for the assistance of needy and deserving students, ...	5,000 00
Whiting Street scholarship fund: —	
Gift of Whiting Street of Northampton, for no special purpose, but to be invested and the income used. This fund is now used exclusively for scholarship, ...	1,000 00
Hills fund: —	
Gift of Leonard M. and Henry F. Hills of Amherst, Mass., in 1867, to establish and maintain a botanic garden, .	10,000 00
Mary Robinson fund: —	
Gift of Miss Mary Robinson of Medfield, in 1874, for scholarship, ...	1,000 00
Grinnell prize fund: —	
Gift of Hon. Wm. Claflin, to be known as the Grinnell agricultural prize, to be given to the two members of the graduating class who may pass the best oral and written examination in theory and practice of agriculture, given in honor of George B. Grinnell of New York, . . .	1,000 00
Gassett scholarship fund: —	
Gift of Henry Gassett of Boston, the income to be used for scholarship, ...	1,000 00
Massachusetts Agricultural College investment fund: —	
Investment made by vote of trustees in 1893 to purchase one share of New York Central & Hudson River Railroad stock. The income from this fund has been allowed to accumulate, ...	100 00

Danforth Keyes Bangs fund: —	
Gift of Louisa A. Baker of Amherst, Mass., April 14, 1909, the income thereof to be used annually in aiding poor, industrious and deserving students to obtain an education in said College, ...	$6,000 00
John C. Cutter fund: —	
Gift of Dr. John C. Cutter of Worcester, Mass., an alumnus of the College, who died in August, 1909, to be invested by the trustees, and the income to be annually used for the purchase of books on hygiene, ...	1,000 00
Alvord dairy scholarship fund: —	
Gift of Henry E. Alvord, who was the first instructor in military tactics, 1869–71, and a professor of agriculture, 1885–87, at this institution. The income of this fund is to be applied to the support of any worthy student of said college, graduate or postgraduate, who may be making a specialty of the study of dairy husbandry (broadly considered), with the intention of becoming an investigator, teacher or special practitioner in connection with the dairy industry, provided that no benefits arising from such fund shall at any time be applied to any person who then uses tobacco in any form, or fermented or spirituous beverages, or is known to have done so within one year next preceding, ...	4,000 00
William R. Sessions fund: —	
In accordance with the request of my deceased wife, Clara Markham Sessions, made in her last will, I bequeath to the trustees of the Massachusetts Agricultural College, Amherst, Mass., the sum of $5,000, it being the amount received by me from the estate of the said Clara Markham Sessions. The said $5,000 to be kept by the said trustees a perpetual fund, the income from which shall be for the use of the Massachusetts Agricultural College; and according to the further request of my deceased wife, made in her last will, this is to be known as the William R. Sessions fund, and is to be a memorial of William R. Sessions; and it is my special request that the said trustees shall make record of the fact that this fund came from the estate of my deceased wife, Clara Markham Sessions, in accordance with her request made in her last will, . .	5,000 00
	$49,100 00

FRED C. KENNEY,
Treasurer.

PUBLIC DOCUMENT No. 31

MASSACHUSETTS AGRICULTURAL COLLEGE

CATALOGUE, 1920-1921

UBLIC DOCUMENT No. 31

THE M. A. C. BULLETIN
AMHERST, MASSACHUSETTS

VOLUME XIII JANUARY, 1921 NUMBER I

PUBLISHED EIGHT TIMES A YEAR BY THE MASSACHUSETTS AGRICULTURAL COLLEGE: JAN., FEB., MARCH, MAY, JUNE, SEPT., OCT., NOV. ENTERED AT THE POST OFFICE, AMHERST, MASS., AS SECOND CLASS MATTER

THE FIFTY-EIGHTH ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE

PART II.—CATALOGUE OF THE COLLEGE FOR 1920-1921

Publication of this Document
approved by the
Supervisor of Administration.

The Commonwealth of Massachusetts

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, NOV. 30, 1920.

To His Excellency CALVIN COOLIDGE.

SIR: — On behalf of the trustees of the Massachusetts Agricultural College I have the honor to transmit herewith, to Your Excellency and the Honorable Council, Part II of the fifty-eighth annual report of the trustees, this being the catalogue of the college.

I am, very respectfully, your obedient servant,

KENYON L. BUTTERFIELD,
President.

CONTENTS.

PAGE

Calendar, 1920–1922, ... 9
Historical Statement, ... 11
Members of the Corporation, ... 14
Officers of the Institution, ... 16
Standing Committees of the Faculty, ... 26
Admission, ... 29
Courses of Instruction, ... 40
Description of Courses, ... 65
Graduate School, ... 145
Short Courses, ... 165
Extension Service, ... 173
General Information, ... 183
Degrees Conferred, ... 199
Registration, ... 202
Index, ... 231

THE MASSACHUSETTS AGRICULTURAL COLLEGE

Without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and mechanic arts in such manner as the legislatures of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. — *Act of Congress, July 2, 1862.*

This issue of the catalogue represents the status of the college for the current college year, with provisional announcement of courses of study and other matters for the year to follow. When deemed necessary, additional announcements are made in a supplementary bulletin, published in the spring.

The college reserves, for itself and its departments, the right to withdraw or change the announcements made in its catalogue.

CALENDAR.

1920-21-22.

REGULAR AND TWO-YEARS' COURSES.

1920.

September 22–25, Wednesday–Saturday,	Entrance examinations.
September 29, Wednesday, 1.30 P.M.,	Fall term begins; assembly.
October 12, Tuesday,	Holiday — Columbus Day.
November 24–26, Wednesday, 12 M.–Friday, 1 P.M.,	Thanksgiving recess.
December 23, Thursday, 5 P.M.,	Fall term ends.

1921.

January 3, Monday, 1 P.M.,	Winter term begins.
February 22, Tuesday,	Holiday — Washington's Birthday.
March 25, Friday, 5 P.M.,	Winter term ends.
April 4, Monday, 1 P.M.,	Spring term begins.
April 19, Tuesday,	Holiday — Patriots' Day.
May 30, Monday,	Holiday — Memorial Day.
June 9–14, Thursday–Tuesday,[1]	Commencement and fiftieth anniversary celebration.
June 30–July 2, Thursday–Saturday,	Entrance examinations.
September 21–24, Wednesday–Saturday,	Entrance examinations.
September 28, Wednesday, 1.30 P.M.,	Fall term begins; assembly.
October 12, Wednesday,	Holiday — Columbus Day.
November 23–25, Wednesday, 12 M.–Friday, 1 P.M.,	Thanksgiving recess.
December 23, Friday, 5 P.M.,	Fall term ends.

1922.

January 2, Monday, 1 P.M.,	Winter term begins.
February 22, Wednesday,	Holiday — Washington's Birthday.
March 24, Friday, 5 P.M.,	Winter term ends.
April 3, Monday, 1 P.M.,	Spring term begins.
April 19, Wednesday,	Holiday — Patriots' Day.
May 30, Tuesday,	Holiday — Memorial Day.
June 24–27, Saturday–Tuesday,	Commencement.
June 29–July 1, Thursday–Saturday,	Entrance examinations.
September 20–23, Wednesday–Saturday,	Entrance examinations.
September 27, Wednesday, 1.30 P.M.,	Fall term begins; assembly.

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[1] The normal dates for Commencement would be June 25–28.

MASSACHUSETTS AGRICULTURAL COLLEGE.

History. — The Massachusetts Agricultural College was organized under the national land grant act of 1862. This legislation is also known as the Morrill act, the original bill having been framed by Justin Smith Morrill, Senator from Vermont, and its final enactment secured under his leadership. It provided that public lands be assigned to the several States and territories, the funds from the sale of which were to be used to establish and maintain colleges of agriculture and mechanic arts. The Massachusetts Agricultural College is among the first of these institutions established. When this act was passed the Massachusetts Institute of Technology was already organized, and the State of Massachusetts definitely decided that the instruction in the mechanic arts should be at the institute, and that the new institution should confine its work to agriculture. On this account the Massachusetts Agricultural College has the unique distinction of being the only separate agricultural college in the country.

In 1863 the State of Massachusetts accepted the provisions of the Morrill act and incorporated the Agricultural College. The location at Amherst was decided only after long and careful study by the original Board of Trustees. The college was formally opened to students on the 2d of October, 1867, with a faculty of four teachers and with four wooden buildings.

The Massachusetts Legislature has granted money for the erection of practically all of the buildings now on the grounds. In view of the fact that the annual income from the original endowment has been only a few thousand dollars, it has been necessary for the State to assume responsibility for the current expenses of the institution.

Organization. — The college is a State institution, and as such is subject to the laws governing and the rules applying to all State departments and institutions. The work of the college is directed by a board of eighteen trustees. Four of these are ex-officio members, — the Governor of the State, the Commissioner of Education, the Commissioner of Agriculture and the president of the college. The other fourteen members are appointed by the Governor for terms of seven years each, or two each year. The immediate control of the institution is vested in the president of the college. The various administrative officers, having supervision of the various departments of activity, are directly responsible to the president.

In carrying out its purpose the college has organized three distinct yet correlated types of work, — namely, research, resident instruction and extension service.

Research. — Massachusetts provided for the establishment of an agricultural experiment station in 1882. This station, though on the college grounds and supported by the State, was without organic connection with the college. Under an act of Congress, passed in 1887, an agricultural experiment station was established and supported as a department of the college.

For a time, therefore, Massachusetts had two experiment stations at the college. In 1894 these were combined, and the station reorganized as a department of the college. It is now supported by funds from both the State and the Federal government. In 1906 the Federal government largely increased its support on condition that the money thus provided should be used only for research. The station now receives about three-fourths of its support from the State.

The station is under the direct supervision of the Board of Trustees; the chief officer is the director, who is responsible to the president. It is organized into a number of departments, all co-operating toward the betterment of agriculture. In most cases the heads of these departments are heads of corresponding departments in the college. The station publishes numerous bulletins and two annual reports, one scientific, the other popular. These publications are free and circulate extensively, the mailing list containing approximately 20,000 addresses.

Resident Instruction. — The college offers an education without tuition fee to any student who is a resident of Massachusetts and who meets the requirements for admission. Women are admitted on the same basis as are men. Students who are not residents of Massachusetts are required to pay a nominal tuition fee. The chief aim of the institution, through its resident instruction, is to prepare men and women for the agricultural vocations. The term "agricultural vocations" is here used in its broadest sense. Courses are offered which give efficient training in various agricultural pursuits, such as general farming, dairying, management of estates, poultry husbandry, fruit growing, market gardening, floriculture, landscape gardening and forestry. Students are also trained for investigation in many sciences underlying the great agricultural industry, for teaching in agricultural colleges and high schools, and for scientific work in chemistry, entomology, botany and microbiology.

Though training for the agricultural vocations is thus the chief concern of the college, students should find the course one that trains them admirably for pursuits in which the sciences are an essential preparation. The course of study aims also to combine an adequate general education with specialized technical and practical training.

Four-year Courses. — Twenty-nine teaching departments offer instruction in agriculture, horticulture, sciences, the humanities, rural social science and rural home making. A system of major courses permits the student to elect major work in one of eighteen departments, and to specialize in it and allied subjects for a period of two years. The degree of bachelor of science is granted on the satisfactory completion of the four years' work of collegiate grade.

Short Courses. — In order to extend the advantages of the institution to those men and women who cannot or do not care to take advantage of the four-year course, various short courses are offered. Chief among these are a two-year course in practical agriculture, a summer school of agriculture and country life, and a winter school of agriculture.

Graduate School. — The graduate school is organized to provide the necessary training for scientific leadership in agriculture and allied sciences. The degrees of master of agriculture, master of landscape architecture, master of science, doctor of agriculture and doctor of philosophy may be earned upon the completion of satisfactory study, research and thesis.

THE EXTENSION SERVICE. — The extension service is an organized effort to carry systematic and dignified instruction to the thousands of people throughout the State who are unable, for various reasons, to take advantage of the regular courses offered at the college. It is in reality the "carrying of the college to the people of the State." Every department of the institution, in so far as the regular teaching and research work will permit, contributes what it can to this work. There is also a regular staff of extension workers whose sole business it is to present the instruction of the college to individuals and various organizations throughout the State.

LOCATION AND EQUIPMENT. — The Agricultural College is located in the town of Amherst. The grounds comprise more than 600 acres, lying about a mile north of the village center. The college has also a demonstration forest of 755 acres, located 6 miles north of the campus. The equipment of the college, both in buildings and facilities for instruction, is excellent. Amherst is 97 miles from Boston, and may be reached by the Central Massachusetts division of the Boston & Maine Railroad, or by the Central Vermont Railroad. Electric car lines connect Amherst with Northampton, Holyoke and Springfield.

MILITARY DRILL. — By Federal law military drill is required of all regular students attending the Massachusetts Agricultural College.

THE CORPORATION.

ORGANIZATION OF 1920.

Members of the Corporation.

	TERM EXPIRES
Elmer D. Howe of Marlborough,	1921
Edmund Mortimer of Grafton,	1921
Nathaniel I. Bowditch of Framingham,	1922
William Wheeler of Concord,	1922
Charles A. Gleason of New Braintree,	1923
James F. Bacon of Boston,	1923
Frank Gerrett of Greenfield,	1924
Harold L. Frost of Arlington,	1924
Charles H. Preston of Danvers,	1925
Carlton D. Richardson of West Brookfield,	1925
Davis R. Dewey of Cambridge,	1926
John F. Gannon of Pittsfield,	1926
Arthur G. Pollard of Lowell,	1927
George H. Ellis of West Newton,	1927

Members Ex Officio.

His Excellency Governor Calvin Coolidge, *President of the Corporation.*
Kenyon L. Butterfield, *President of the College.*
Payson Smith, *State Commissioner of Education.*
Arthur W. Gilbert, *State Commissioner of Agriculture.*

Officers of the Corporation.

His Excellency Governor Calvin Coolidge of Northampton, *President.*
Charles A. Gleason of New Braintree, *Vice-President.*
Ralph J. Watts of Amherst, *Secretary.*
Fred C. Kenney of Amherst, *Treasurer.*
Charles A. Gleason of New Braintree, *Auditor.*

Standing Committees of the Corporation.[1]

Committee on Finance.

Charles A. Gleason, *Chairman.*
George H. Ellis.
Nathaniel I. Bowditch.
Arthur G. Pollard.
Carlton D. Richardson.
Edmund Mortimer.

Committee on Course of Study and Faculty.

William Wheeler, *Chairman.*
Elmer D. Howe.
Payson Smith.
Davis R. Dewey.
John F. Gannon.
James F. Bacon.

Committee on Farm.

Nathaniel I. Bowditch, *Chairman.*
Frank Gerrett.
Carlton D. Richardson.
George H. Ellis.
Edmund Mortimer.
Arthur W. Gilbert.

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[1] The president of the college is ex-officio member of each committee.

Committee on Horticulture.

Harold L. Frost, *Chairman.*
Charles A. Gleason.
Edmund Mortimer.
Elmer D. Howe.
Arthur W. Gilbert.
Charles H. Preston.

Committee on Experiment Department.

Charles H. Preston, *Chairman.*
Arthur W. Gilbert.
Arthur G. Pollard.
Harold L. Frost.
Edmund Mortimer.

Committee on Buildings and Arrangement of Grounds.

Frank Gerrett, *Chairman.*
William Wheeler.
Charles H. Preston.
George H. Ellis.
James F. Bacon.

Committee on Extension Service.

Elmer D. Howe, *Chairman.*
George H. Ellis.
Harold L. Frost.
Davis R. Dewey.
Nathaniel I. Bowditch.
John F. Gannon.
Arthur W. Gilbert.

Officers of the Institution.

As of Nov. 30, 1920.

OFFICERS OF GENERAL ADMINISTRATION.

Kenyon L. Butterfield, A.M., LL.D., President of the College.	President's House.
George M. Campbell, B.Sc., Field Agent.	83 Pleasant Street.
Charles H. Fernald, Ph.D., Honorary Director of the Graduate School.	3 Hallock Street.
Charles R. Green, B.Agr., Librarian.	Mount Pleasant.
Philip B. Hasbrouck, B.Sc., Registrar.	31 Fearing Street.
Sidney B. Haskell, B.Sc., Director of the Experiment Station.	Mount Pleasant.
Fred C. Kenney, Treasurer of the College.	Mount Pleasant.
Edward M. Lewis, A.M., Dean of the College.	19 Lincoln Avenue.
Charles E. Marshall, Ph.D., Director of the Graduate School.	44 Sunset Avenue.
John Phelan, A.M., Director of Short Courses.	5 Mount Pleasant.
Ralph J. Watts, B.Sc., Secretary of the College.	101 Butterfield Terrace.
John D. Willard, B.A., Director of the Extension Service.	East Pleasant Street.

THE FACULTY OF INSTRUCTION.

Kenyon L. Butterfield, A.M., LL.D., President of the College and Head of the Division of Rural Social Science.	President's House.
Charles H. Abbott, Ph.D., Instructor in Zoölogy.	3 Dana Street.
Max F. Abell, B.Sc., Assistant Professor of Farm Management.	North Amherst.
Paul J. Anderson, Ph.D., Professor of Botany.	25 Lincoln Avenue.
Edgar L. Ashley, A.M., Professor of German.	24 Pleasant Street.
Luther Banta, B.Sc., Assistant Professor of Poultry Husbandry.	70 Lincoln Avenue.
Arthur B. Beaumont, Ph.D., Professor of Agronomy and Head of Department.	51 Amity Street.
Alexander E. Cance, Ph.D., Professor of Agricultural Economics and Head of Department.	9 Fearing Street.
Joseph S. Chamberlain, Ph.D., Professor of Organic and Agricultural Chemistry.	Mount Pleasant.

Walter W. Chenoweth, M.Sc., ... North Amherst.
Professor of Horticultural Manufactures and Head of Department.

Francis P. Clark, B.Sc., ... 24 Pleasant Street.
Instructor in Mathematics.

Orton L. Clark, B.Sc., ... 16 College Street.
Assistant Professor of Botany.

Guy C. Crampton, Ph.D., ... 116 Pleasant Street.
Professor of Insect Morphology.

Arthur L. Dacy, B.Sc., ... 2 Allen Street.
Professor of Vegetable Gardening.

William L. Dowd, B.Sc.,[1] . . . . North Amherst.
Instructor in Entomology.

Brooks D. Drain, B.Sc., ... 24 Pleasant Street.
Assistant Professor of Pomology.

Henry T. Fernald, Ph.D., ... 44 Amity Street.
Professor of Entomology, Head of Department, Chairman of Division of Science.

James A. Foord, M.Sc., ... 54 Lincoln Avenue.
Professor of Farm Management, Head of Department, Head of Division of Agriculture.

Willard K. French, B.Sc., ... 24 Pleasant Street.
Assistant Professor of Farm Management.

George E. Gage, M.A., Ph.D., ... The Davenport.
Professor of Animal Pathology.

Helena T. Goessman, M.Ph., ... 21 Pleasant Street.
Instructor of English.

Clarence E. Gordon, Ph.D., ... 38 Lincoln Avenue.
Professor of Zoölogy and Geology and Head of Department.

Harold M. Gore, B.Sc., ... The Davenport.
Assistant Professor of Physical Education.

Charles H. Gould, B.Sc., ... 12 Chestnut Street.
Instructor in Pomology.

John C. Graham, B.Sc., ... 68 Lincoln Avenue.
Professor of Poultry Husbandry and Head of Department.

Emory E. Grayson, B.Sc., ... Belchertown.
Instructor in Physical Education.

Laurence R. Grose, A.B., M.F., ... 45 Amity Street.
Professor of Forestry and Head of Department.

Christian I. Gunness, B.Sc., ... 105 Butterfield Terrace.
Professor of Rural Engineering and Head of Department.

Margaret Hamlin, B.A., ... 12 North East Street.
Agricultural Counsellor for Women.

Elmer A. Harrington, A.M., Ph.D., ... 7 Allen Street.
Professor of Physics.

Roy D. Harris, B.Sc., ... Care of Mrs. H. D. Fearing.
Instructor in Market Gardening.

Arthur K. Harrison, ... 6 Allen Street.
Assistant Professor of Landscape Gardening.

William R. Hart, LL.B., M.A., ... 97 Pleasant Street.
Professor of Agricultural Education and Head of Department.

Philip B. Hasbrouck, B.Sc., ... 31 Fearing Street.
Professor of Physics and Head of Department.

Curry S. Hicks, B.Pd., ... The Davenport.
Professor of Physical Education and Hygiene and Head of Department.

Mrs. Curry S. Hicks,[1] . . . . The Davenport.
Instructor in Physical Education.

Arao Itano, Ph.D., ... 3 Fearing Street.
Assistant Professor of Microbiology.

Brooks F. Jakeman, B.Sc., ... North College.
Instructor in Physical Education.

Henry F. Judkins, B.Sc., ... 103 Butterfield Terrace.
Professor of Dairying.

Arthur N. Julian, A.B., ... 4 Farview Way.
Assistant Professor of German.

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[1] Temporary position.

Edward M. Lewis, A.M., ... 19 Lincoln Avenue.
Professor of Languages and Literature, Head of Department, Acting Head of Division of the Humanities.

Joseph B. Lindsey, Ph.D., ... 47 Lincoln Avenue.
Goessmann Professor of Agricultural Chemistry and Head of Department.

William P. B. Lockwood, M.Sc., ... 34 North Prospect Street.
Professor of Dairying and Head of Department.

William L. Machmer, A.M., ... 3 Kendrick Place.
Professor of Mathematics and Assistant Dean.

Alexander A. Mackimmie, A.M., ... Pine Street, North Amherst.
Professor of French.

Charles E. Marshall, Ph.D., ... 44 Sunset Avenue.
Professor of Microbiology and Head of Department.

Frederick A. McLaughlin, B.Sc., ... 15 Fearing Street.
Assistant Professor of Botany.

Frank C. Moore, A.B., ... 10 Allen Street.
Assistant Professor of Mathematics.

James M. Neill, B.Sc., ... North Amherst.
Instructor in Microbiology.

John B. Newlon, ... 94 Pleasant Street.
Instructor in Rural Engineering.

Joseph F. Novitski, B.Sc.,[1] . . . . 6 Phillips Street.
Instructor in Rural Sociology.

A. Vincent Osmun, M.Sc., ... 16 Northampton Road.
Professor of Botany and Head of Department.

John E. Ostrander, A.M., C.E., ... 33 North Prospect Street.
Professor of Mathematics and Head of Department.

James B. Paige, B.Sc., D.V.S., ... 42 Lincoln Avenue.
Professor of Veterinary Science and Head of Department.

Laurence H. Parker, A.B., ... The Davenport.
Assistant Professor of Citizenship and Acting Head of Department of Economics and Sociology.

Charles H. Patterson, A.M., ... 26 Lincoln Avenue.
Professor of English.

Loyal F. Payne, B.Sc., ... 33 East Pleasant Street.
Professor of Poultry Husbandry.

Charles A. Peters, Ph.D., ... Sunset Place.
Professor of Inorganic and Soil Chemistry.

John Phelan, A.M., ... 5 Mount Pleasant.
Professor of Rural Sociology and Head of Department.

Walter E. Prince, A.M., ... 25 Amity Street.
Assistant Professor of English.

George F. Pushee, ... North Amherst.
Instructor in Rural Engineering.

Frank P. Rand, M.A., ... North Amherst.
Instructor in English.

William S. Regan, Ph.D., ... 84 Pleasant Street.
Assistant Professor of Entomology.

Victor A. Rice, B.S.Agr., ... Woodside Avenue.
Assistant Professor of Animal Husbandry.

William F. Robertson, B.Sc., ... 24 Pleasant Street.
Instructor in Horticultural Manufactures.

William E. Ryan, B.Sc., ... 30 North Prospect Street.
Instructor in Poultry Husbandry.

Schuyler M. Salisbury, B.Sc., B.S.Agr., ... 12 Nutting Avenue.
Professor of Animal Husbandry and Head of Department.

Donald W. Sawtelle, M.Sc., ... 13 Fearing Street.
Instructor in Agricultural Economics.

Fred C. Sears, M.Sc., ... Mount Pleasant.
Professor of Pomology and Head of Department.

Paul Serex, M.Sc., ... 5 East Pleasant Street.
Assistant Professor of Chemistry.

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[1] On leave of absence.

Frederick E. Shnyder, Major, Cavalry, U. S. A., ... Amherst House.
Assistant Professor of Military Science and Tactics.
Newell L. Sims, A.M., Ph.D., ... 60 Pleasant Street.
Professor of Rural Sociology.
Edna L. Skinner, B.Sc., ... 50 Lincoln Avenue.
Professor of Home Economics, Head of Department, Adviser of Women.
Robert J. Sprague, Ph.D.,[1] . . . . Mount Pleasant.
Professor of Economics and Sociology and Head of Department.
James L. Strahan, M.Sc., ... 50 Amity Street.
Assistant Professor of Rural Engineering.
Mrs. Julia G. Strahan, B.Sc., ... 50 Amity Street.
Instructor in Home Economics.
Charles H. Thayer, ... Hickory Farm, Amherst.
Instructor in Agronomy.
Clark L. Thayer, B.Sc., ... The Davenport.
Professor of Floriculture and Head of Department.
Weston C. Thayer, B.Sc., ... 14 Nutting Avenue.
Instructor in Animal Husbandry.
Guy A. Thelin, B.Sc., ... 24 Pleasant Street.
Instructor in Agronomy.
Charles H. Thompson, M.Sc., ... Mount Pleasant.
Assistant Professor of Horticulture.
Harold F. Tompson, B.Sc., ... 10 Temple Street, Arlington.
Professor of Vegetable Gardening and Head of Department.
Ray E. Torrey, Ph.D., ... 24 Pleasant Street.
Instructor in Botany.
Alfred L. Tower, B.Sc., ... Mount Pleasant.
Instructor in Physics.
Glen E. Upton, B.Sc., ... 24 Pleasant Street.
Instructor in Dairying.
Richard W. Walker, U. S. A., Lieut.-Col., Cavalry, U. S. A., . . Mount Pleasant.
Professor of Military Science and Tactics.
Frank A. Waugh, M.Sc., ... Campus.
Professor of Landscape Gardening, Head of Department, Head of Division of Horticulture.
Winthrop S. Welles, B.Sc., ... 23 Lincoln Avenue.
Professor of Agricultural Education.
Charles Wellington, Ph.D., ... 34 Amity Street.
Professor of Chemistry.
T. George Yaxis, M.Sc., ... Tillson Court.
Assistant Professor of Dairying.

——— ———, ... – –
Assistant Professor of Agronomy.

——— ———, ... – –
Professor of English.

——— ———, ... – –
Professor of Chemistry.

——— ———, ... – –
Professor of Beekeeping.

——— ———, ... – –
Instructor in French.

STAFF EMPLOYED FOR WORK FOR FEDERAL BOARD FOR VOCATIONAL EDUCATION.

Mrs. Grace D. Beaumont, A.B., ... 51 Amity Street.
Instructor in English.
Edward J. Burke, B.Sc., ... 24 Pleasant Street.
Instructor in Pomology.
Charles G. Crocker, ... 24 Pleasant Street.
Instructor in Agronomy.
Mrs. Elsie V. Crocker, ... North Amherst.
Clerk.

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[1] On leave of absence.

Ralph H. Denman, B.Sc., Assistant Professor of Rural Engineering.	70 Lincoln Avenue.
Harlow L. Pendleton, B.Sc., Instructor in Dairying.	103 Butterfield Terrace.
Mrs. Ida D. Phelan, Instructor in English.	5 Mount Pleasant.
Loring V. Tirrell, B.Sc., Instructor in Animal Husbandry.	Theta Chi House.
Paul W. Viets, Student Adviser.	5 Hitchcock Street.

THE EXPERIMENT STATION STAFF.

Kenyon L. Butterfield, A.M., LL.D., President of the College.	President's House.
Sidney B. Haskell, B.Sc., Director of the Experiment Station.	Mount Pleasant.
James R. Alcock, Assistant in Animal Nutrition.	North Amherst.
Harry L. Allen, Laboratory Assistant, Chemistry.	89 Main Street.
Paul J. Anderson, Ph.D., Professor of Botany.	25 Lincoln Avenue.
Alyn S. Ball, Laboratory Assistant, Botany.	11 Whitney Street.
Carlos L. Beals, B.Sc., Assistant Research Professor of Chemistry.	10 Nutting Avenue.
Arthur I. Bourne, B.A., Investigator in Entomology.	12 East Pleasant Street.
William P. Brooks, Ph.D., Consulting Agriculturist.	6 Farview Way.
Alexander E. Cance, Ph.D., Professor of Agricultural Economics.	9 Fearing Street.
George H. Chapman, Ph.D., Research Professor of Botany.	31 Lincoln Avenue.
Walter W. Chenoweth, M.Sc., Professor of Horticultural Manufactures.	North Amherst.
Orton L. Clark, B.Sc., Assistant Professor of Botany.	16 College Street.
Robert L. Coffin, Investigator in Agriculture.	19 Phillips Street.
Henry T. Fernald, Ph.D., Professor of Entomology.	44 Amity Street.
Henry J. Franklin, Ph.D., Research Professor in charge of Cranberry Substation.	East Wareham.
George E. Gage, M.A., Ph.D., Professor of Animal Pathology.	The Davenport.
Edwin F. Gaskill, B.Sc., Assistant Research Professor of Agriculture.	North Pleasant Street.
Hubert D. Goodale, Ph.D., Research Professor of Poultry Husbandry.	North Amherst.
John C. Graham, B.Sc., Professor of Poultry Husbandry.	68 Lincoln Avenue.
Edward B. Holland, Ph.D., Research Professor of Chemistry.	28 North Prospect Street.
Marguerite G. Ickis, M.A., Curator, Department of Botany.	The Davenport.
Arao Itano, Ph.D., Assistant Professor of Microbiology.	3 Fearing Street.
Lorian P. Jefferson, M.A., Assistant Research Professor of Agricultural Economics.	84 Pleasant Street.
Carlton P. Jones, M.Sc., Assistant Research Professor of Chemistry.	8 Nutting Avenue.

Webster S. Krout, B.Sc., M.A., Assistant Research Professor of Botany.	17 Fearing Street.
John B. Lentz, A.B., V.M.D., Assistant Research Professor of Veterinary Science.	12 Northampton Road.
Joseph B. Lindsey, Ph.D., Vice-Director and Chemist.	47 Lincoln Avenue.
Charles E. Marshall, Ph.D., Professor of Microbiology.	44 Sunset Avenue.
Anne C. Messer, A.B., Investigator in Chemistry.	10 Kellogg Avenue.
Fred W. Morse, M.Sc., Research Professor of Chemistry.	40 Pleasant Street.
A. Vincent Osmun, M.S., Professor of Botany.	16 Northampton Road.
John E. Ostrander, A.M., C.E., Meteorologist.	33 North Prospect Street.
James B. Paige, B.Sc., D.V.S., Professor of Veterinary Science.	42 Lincoln Avenue.
Fred C. Sears, M.Sc., Professor of Pomology.	Mount Pleasant.
Jacob K. Shaw, Ph.D., Research Professor of Pomology.	5 Farview Way.
Harold F. Tompson, B.Sc., In charge of Market-garden Field Station.	10 Temple Street, Arlington.
Frank A. Waugh, M.Sc., Head of Division of Horticulture.	Campus.
Harlan N. Worthley, B.Sc., Investigator in Entomology.	Mount Pleasant.

CONTROL SERVICE STAFF.

Ethel M. Bradley, B.Sc., Analyst.	79 Pleasant Street.
Henri D. Haskins, B.Sc., Official Chemist, Fertilizer Control.	14 Amity Street.
James T. Howard, Inspector.	46 Pleasant Street.
Philip H. Smith, M.Sc., Official Chemist, Feed Control.	102 Main Street.
Raymond W. Swift, B.Sc., Analyst.	North Amherst.
Lewell S. Walker, B.Sc., Assistant Official Chemist, Fertilizer Control.	10 Phillips Street.

THE EXTENSION SERVICE STAFF.

Kenyon L. Butterfield, A.M., LL.D., President of the College.	President's House.
John D. Willard, B.A., Director.	East Pleasant Street.
William R. Cole, Assistant Extension Professor of Horticultural Manufactures.	5 East Pleasant Street.
Laura Comstock,[1] Supervisor, Home Demonstration Projects.	84 Pleasant Street.
George L. Farley, B.Sc., Supervisor of Junior Extension Work.	22 Dana Street.
Robert D. Hawley, B.Sc., Supervisor of Extension Schools and Exhibits.	83 Pleasant Street.
William F. Howe, Assistant Supervisor of Junior Extension Work.	8 North Prospect Street.
Louis M. Lyons, B.Sc., Extension Editor and Supervisor of Correspondence Courses.	83 Pleasant Street.

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[1] On leave of absence.

Allister F. McDougall, B.Sc., ... North Amherst.
Extension Professor of Farm Management.

Robert J. McFall, A.M., Ph.D., ... 20 Spring Street.
Extension Professor of Agricultural Economics.

William C. Monahan, B.Sc., ... 34 Pleasant Street.
Extension Professor of Poultry Husbandry.

Earle H. Nodine, ... 24 Pleasant Street.
Extension Instructor in charge of Poultry Club Work.

Helen M. Norris, ... 87 Pleasant Street.
Extension Instructor in Agricultural Education.

Sumner R. Parker, B.Sc., ... South Amherst.
Supervisor of County Agent Projects.

William E. Philbrick, B.Sc.,[1] . . . . 24 Pleasant Street.
Assistant Extension Professor of Landscape Gardening.

Lucy M. Queal, B.Sc.,[2] . . . . 7 Woodside Avenue.
Assistant Supervisor, State Home Demonstration Projects.

Ralph W. Redman, B.Sc., ... Mount Pleasant.
Assistant Director.

Mrs. Ruth Reed, ... Lynn.
Assistant Extension Professor of Home Economics.

Marie Sayles, ... The Davenport.
Assistant Supervisor, State Home Demonstration Projects.

Ralph A. Van Meter, B.Sc., ... 1 Bank Block.
Assistant Extension Professor of Pomology.

—— —— . . . . – –
Assistant Extension Professor of Agricultural Economics.

—— —— . . . . – –
Extension Professor of Rural Community Organization.

—— —— . . . . – –
Extension Professor of Animal Husbandry.

—— —— . . . . – –
Extension Professor of Dairying.

—— —— . . . . – –
Extension Professor of Soils and Crops.

THE CLERICAL STAFF.

Mrs. Ester W. Arp, ... 30 Cottage Street.
Stenographer, Extension Service.

May G. Arthur, ... Northampton.
Stenographer, Department of Rural Home Life.

Mrs. Celena M. Baxter, ... Draper Hall.
Stenographer, Graduate School and Department of Microbiology.

Eleanor F. Bishop, ... 3 Spaulding Street.
Bookkeeper, Treasurer's Office.

John K. Broadfoot, ... 130 Pleasant Street.
Cashier, Treasurer's Office.

Mary L. Broadfoot, ... 130 Pleasant Street.
Clerk, Treasurer's Office.

Ruth L. Brown, ... North Amherst.
Clerk, Department of Dairying.

Mrs. Lucia G. Church, ... North Amherst.
Secretary to the Director of the Experiment Station.

Susan Clark, ... Northampton.
Stenographer, Extension Service.

Grace Corbett, ... Draper Hall.
Bookkeeper, Treasurer's Office.

Irene Crutch, ... South Amherst.
Stenographer, Division of Agriculture.

Viola Damon, ... Bank Block.
Stenographer, Division of Horticulture.

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[1] Appointment effective Jan. 1, 1921.

[2] Temporary position.

Emily G. Davidson, Telephone Operator.	10 Maple Street.
Margaret G. Davidson, Clerk, Extension Service.	10 Maple Street.
Florence E. Day, Stenographer, Extension Service.	8 Spaulding Street.
Rose Delaney, Stenographer, Department of Rural Sociology.	79 Pleasant Street.
Hazel E. Donovan, Clerk, Power Plant.	Draper Hall.
F. Ethel Felton, A.B., Clerk and Editorial Assistant, Experiment Station.	Draper Hall.
Margaret Fish, Stenographer, President's Office.	43 Fearing Street.
Lina E. Fisher, Clerk, Department of Chemistry.	28 Pleasant Street.
Grace Gallond, Stenographer, Department of Dairying.	28 Pleasant Street.
Katherine Gardner, A.B., Stenographer, Division of Agriculture.	87 Pleasant Street.
Cora B. Grover, Stenographer, Control Service.	North Amherst.
Amy Hamilton, Stenographer, Department of Agricultural Education.	Savings Bank Block.
Katherine Harris, Stenographer, Department of Agronomy.	3 Pleasant Street.
E. Franklin Holland, Clerk, Department of Physical Education.	79 Pleasant Street.
Gertrude Hollis, Stenographer, Dean's Office.	8 Nutting Avenue.
Catherine E. Honney, Stenographer, President's Office.	Lincoln Avenue.
Mary E. Horton, Stenographer, President's Office.	79 Pleasant Street.
Elizabeth M. Kiley, Stenographer, Department of Entomology.	Northampton.
Marguerite C. Leduc, Chief Clerk, Extension Service.	Northampton.
Honoria Lee, Stenographer, Division of Horticulture.	38 Cottage Street.
Aline J. Legare, Stenographer, Division of Agriculture.	Northampton.
Helen Martin, Clerk, Treasurer's Office.	5 Phillips Street.
Marion B. Macarty, Stenographer, Treasurer's Office.	5 Fearing Street.
Edith Meehan, Stenographer, Market-garden Field Station.	1122 Massachusetts Avenue, Arlington.
Rebecca L. Mellor, Stenographer, Experiment Station.	10 Kellogg Avenue.
Marie A. Mercier, Clerk, Short Courses.	Northampton.
Doris Millett, Stenographer, Extension Service.	13 Main Street.
Gladys I. Miner, Stenographer, Department of Botany.	73 Pleasant Street.
Mrs. Jessie A. Neill, Clerk, Treasurer's Office.	North Amherst.
Bridie E. O'Donnell, Stenographer, Department of Entomology.	Hadley.
Julietta O'Donnell, Stenographer, Registrar's Office.	North Amherst.
Corinne T. Petit, Stenographer, Extension Service.	East Pleasant Street.

Mildred Pierpont, A.B., ... East Pleasant Street.
Stenographer, Short Courses.

Mildred Putney, ... Leverett.
Stenographer, Department of Agricultural Economics.

Helen Rand, A.M., ... Care of Mrs. H. D. Fearing.
Private Secretary, Division of Rural Social Science.

Helen Reardon, ... Hadley.
Stenographer, Extension Service.

Josephine B. Reed, ... North Prospect Street.
Stenographer, Extension Service.

Edith C. Robinson, ... 73 Pleasant Street.
Secretary to the President.

Mrs. Ruth L. Rodwaye, ... 9 Gaylord Street.
Clerk, Treasurer's Office.

Ora E. Rouleau, ... 10 Dickinson Street.
Stenographer, Division of Horticulture.

Ruby Sanborn, A.B., ... 45 Pleasant Street.
Clerk, Department of Poultry Husbandry.

Mrs. Mary I. Shores, ... 35 South Pleasant Street.
Clerk, Dean's Office.

Sadie Shores, ... 35 South Pleasant Street.
Clerk, Extension Service.

Harriet A. Smith, ... Northampton.
Clerk, President's Office.

Mary A. Smith, B.A., ... 46 Pleasant Street.
Stenographer, Department of Agricultural Economics.

Elizabeth Strachan, ... 17 High Street.
Bookkeeper, Treasurer's Office.

Ethelyn Streeter, ... 55 Amity Street.
Stenographer, Division of Horticulture.

Mrs. Laura S. Tower, ... Mount Pleasant.
Stenographer, Department of Poultry Husbandry.

Doris Tower, ... 55 Amity Street.
Stenographer, Department of Poultry Husbandry.

Olive M. Turner, B.Sc., ... 22 Spaulding Street.
Clerk, Registrar's Office.

Catherine White, ... East Pleasant Street.
Stenographer, Extension Service.

—— —— . . . . – –
Stenographer, Department of Dairying.

—— —— . . . . – –
Stenographer, Extension Service.

THE LIBRARY STAFF.

Charles R. Green, B.Agr., ... Mount Pleasant.
Librarian.

Florence Archibald, ... 87 Pleasant Street.
Assistant.

Margery Burnett, ... Draper Hall.
Department Librarian.

Lena V. Chapman, ... 77 South Pleasant Street.
Assistant in charge of Circulation.

Florence B. Kimball, B.A., ... 87 Pleasant Street.
Cataloguer.

Katharine J. Middleton, ... Draper Hall.
Department Librarian.

OTHER OFFICERS.

Mrs. Jessie Bacharach, ... Adams House.
Matron.

Thomas F. Butterworth, ... 3 Phillips Street.
Engineer.

Grace Charman, Resident Nurse.	Infirmary.
Marguerite Davis, Resident Nurse.	Infirmary.
Lawrence S. Dickinson, B.Sc., Superintendent of Grounds.	2 Farview Way.
Lulu Diether, Manager of the Dining Hall.	Draper Hall.
Clarence A. Jewett, Superintendent of Buildings.	112 Pleasant Street.
John J. Lee, Assistant to Military Detail.	38 Cottage Street.
William Martin, Laboratory Assistant, Department of Horticultural Manufactures.	5 Phillips Street.
Enos J. Montague, B.Sc., Farm Superintendent.	Campus.
Adelbert Sheffield, Superintendent of Dairy Manufactures.	North Amherst.
James Whiting, Foreman, Department of Floriculture.	16 Hallock Street.

GRADUATE ASSISTANTS.

Roy C. Avery, B.Sc., Department of Microbiology.	15 Spring Street.
Elizabeth Coleman, A.B., Department of Microbiology.	Adams House.
Richard J. Drexel, B.S.A., Department of Pomology.	24 Pleasant Street.
Herbert M. Emery, B.Sc., Department of Botany.	Clark Hall.
Ambrose C. Faneuf, B.Sc., Department of Chemistry.	Chemistry Building.
Rowland B. French, B.S., Department of Chemistry.	Chemistry Building.
Mary E. Garvey, B.Sc., Department of Microbiology.	27 South Prospect Street.
Conrad H. Lieber, B.Sc., Department of Microbiology.	3 Nutting Avenue.
Randall R. Porter, B.Sc., Department of Chemistry.	Cottage Street.
Joseph R. Sanborn, B.Sc., Department of Microbiology.	North Amherst.
Reginald K. Stratford, B.S.A., Department of Chemistry.	Chemistry Building.

STANDING COMMITTEES OF THE FACULTY.

1920-21.

COMMENCEMENT.

Dean LEWIS.
Treasurer KENNEY.
Major WALKER.
Professor MACHMER.
Secretary WATTS.
Mr. S. R. PARKER.
Professor THAYER.
Mr. CAMPBELL.

COURSE OF STUDY.

President BUTTERFIELD.
Dean LEWIS.
Professor HART.
Professor WAUGH.
Professor PATTERSON.
Professor FERNALD.
Professor OSTRANDER.
Professor MARSHALL.
Professor CHAMBERLAIN.
Professor PHELAN.
Professor FOORD.

DISCIPLINE.

Dean LEWIS.
Professor MACHMER.
Professor PHELAN.
Professor LOCKWOOD.
Professor HICKS.

EMPLOYMENT.

Professor PAYNE.
Treasurer KENNEY.
Secretary WATTS.
Professor THAYER.

NON-ATHLETIC BOARD.

Professor LOCKWOOD.
Professor MACHMER.

ENTRANCE EXAMINATIONS AND ADMISSION.

Professor HASBROUCK.
Professor PATTERSON.
Professor OSMUN.
Professor ASHLEY.
Professor MACHMER.

HEALTH AND SANITATION.

Professor MARSHALL.
Dean LEWIS.
Treasurer KENNEY.
Professor HICKS.
Miss SKINNER.

LIBRARY.

Professor MARSHALL.
Professor PATTERSON.
Professor CANCE.
Mr. GREEN.

SCHOLARSHIP.

Professor MACHMER.
Dean LEWIS.
Professor HASBROUCK.
Professor CHAMBERLAIN.
Mr. RAND.
Professor MACKIMMIE.
Professor PATTERSON.
Assistant Professor PARKER.
Professor HICKS.

STUDENT LIFE.

Professor PATTERSON.
Secretary WATTS.
Professor PHELAN.
Professor SEARS.
Professor CHAMBERLAIN.
Professor LOCKWOOD.
Professor THAYER.

ATHLETIC BOARD.

Dean LEWIS.
Professor HASBROUCK.
Professor OSMUN.

THE COLLEGE

ADMISSION.

A. Application for Admission.

All correspondence concerning admission should be addressed to the registrar.

Every applicant for admission to the college must be at least sixteen years old, and must present to the registrar proper testimonials of good character. Such testimonials, whenever possible, should come from the principal of the school at which the applicant has prepared for college. Candidates who desire to present themselves for examination in any subjects must make application to the college for such privilege at least one month before examination is desired. Blanks for such application may be obtained by addressing the registrar of the college. All entrance credentials must be in the hands of the registrar before the applicant can matriculate.

B. Modes of Admission.

Students are admitted to the freshman class either upon certificate or upon examination. No *diploma* from a secondary school will be accepted.

Certificates. — Certificates will be received from those schools in New England which have been approved by the New England College Entrance Certificate Board. Principals of schools in New England who desire the certificate privilege should address the secretary of the Board, Professor Frank W. Nicolson, Wesleyan University, Middletown, Conn. Certificates from schools outside of New England may be received if those schools are on the approved list of the leading colleges of the section in which the school in question is located.

The credentials of the Board of Regents of the State of New York are accepted as satisfying the entrance requirements of this college when offered subject for subject.

Certificates in order to be accepted must present at least three of the necessary fourteen credits. It is to be understood, however, that responsibility for certification in either elementary French, elementary German, English 1 or English 2, Latin A, Greek A or algebra must be assumed by one school, if the candidate has received his preparation in any one subject named above in more than one school. Subjects lacking on certificate (except for the permitted number of conditions) must be made up at the time of the examinations for admission.

Blank forms for certification — sent to principals or school superintendents only — may be obtained on application to the registrar of the college.

Examinations. — The examination in each subject may be oral or written, or both. The standard required for passing an examination for admission is 65 per cent. Conditions to the amount of two units will be allowed.

Entrance examination for admission to the Massachusetts Agricultural College will be held at the following centers: —

In June, ...	Amherst, Department of Physics building. Massachusetts Institute of Technology, Cambridge, Mass. Worcester, Horticultural Hall.
In September, ...	Amherst, Department of Physics building.

Please note that September examinations are held in Amherst only.

Schedule for Entrance Examinations, June 30–July 2, inclusive, 1921. — The examinations in June will follow this schedule: —

First Day.

7.45 A.M. Registration.
8.00 A.M. Plane geometry.
10.00 A.M. Chemistry.
11.30 A.M. Botany.
2.00 P.M. Solid geometry.
4.00 P.M. Physics.

Second Day.

8.00 A.M. English 1 and 2.
11.00 A.M. Algebra.
2.00 P.M. History (ancient; medieval and modern; English; general; United States and civics).

Third Day.

8.00 A.M. French, German, Spanish, required and elective.
1.00 P.M. Latin, elementary, intermediate and advanced, and all one-half credit electives, except those already noted.

Schedule for Entrance Examinations in September. — In September, 1921, the examinations will be given September 21–24, inclusive, and will follow the order indicated below: —

First Day.

1.00 P.M. Registration.
1.15-5.00 P.M. Greek, elementary and intermediate.

Second Day.

8.00 A.M. Plane geometry.
10.00 A.M. Chemistry.
11.30 A.M. Botany.
2.00 P.M. Solid geometry.
4.00 P.M. Physics.

Third Day.

8.00 A.M. English 1 and 2.
11.00 A.M. Algebra, agriculture.
2.00 P.M. History (ancient; medieval and modern; English; general; United States and civics).

Fourth Day.

8.00 A.M. French, German, Spanish, required and elective.
1.00 P.M. Latin, elementary, intermediate and advanced, and all one-half credit electives, except those already noted.

C. Requirements for Admission.

The requirements for admission are based on the completion of a four-year high school course, or its equivalent, and are stated in terms of units. The term unit means the equivalent of at least four recitations a week for a school year.

Fourteen and one-half units must be offered for admission in accordance with the entrance requirements as stated below. Entrance credits gained either by certificate or by examination will hold good for one year.

Entrance Requirements.

1. *Prescribed.* — The following units are prescribed: —

English 1,	1½
English 2,	1½
A foreign language,	2
Algebra,	1½
Plane geometry,	1
	7½

2. *Restricted Electives.* — Three units to be selected from —

Science,	1, 2 or 3
History (American history and civics included),	1, 2 or 3
A second foreign language,	2 or 3
Additional work in first foreign language,	1 or 2.

3. *Free Margin.* — Free margin of four units to consist of any substantial work (including agriculture,[1] general science and a fourth year of English) for which credit of not less than one-half unit earned in one year is given toward a secondary school diploma.

Units presented in the free margin group are not to be offered by examination or by certificate, but presented by submitting a principal's statement to the effect that such units have been earned in a secondary school, and have been credited toward a diploma issued by such a school.

4. One unit of history must be offered in either the restricted electives or the free margin.

5. If elementary algebra and plane geometry are counted as three units, the total requirement will be fifteen units.

6. Both the credits under the prescribed group and the restricted elective group must be presented either by certificate from an approved school or by examination, or by a combination of both.

The following is a list of subjects in which the entrance credits must be offered in the prescribed and restricted elective groups: —

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[1] See page 32 for details.

Mathematics and Science.

Botany,[1]	½ or 1
Chemistry,[1]	1
Algebra,	1½
Plane geometry,	1
Solid geometry,	½
Trigonometry,	½
Physics,[1]	1
Geology,	½
Physical geography,	½
Physiology,	½
Zoölogy,[1]	½

History.

Ancient,	1
Medieval and modern,	1
English,	1
General,	1
United States and civics,	1

English.

English 1,	1½
English 2,	1½

Foreign Language.

Elementary French,	2
Elementary German,	2
Elementary Spanish,	2
Elementary Latin,	2
Elementary Greek,[2]	2
Intermediate French,	1
Intermediate German,	1
Intermediate Spanish,	1
Intermediate Latin,	1
Intermediate Greek,[2]	1
Advanced French,	1
Advanced German,	1
Advanced Spanish,	1
Advanced Latin,	1

No applicant deficient in both algebra and plane geometry will be admitted.

PRESENTATION OF NOTE-BOOKS. — The keeping of a note-book is required as part of the preparation in those subjects indicated (see note 2, below).

Candidates presenting themselves for examination in such subjects must present at the same time the required note-book, properly certified by the principal. Candidates presenting such subjects on certificates should not present note-books; but their certificates must state that note-books have been satisfactorily completed.

D. Statement of Preparation Required for Admission.

Agriculture. — Entrance credit in agriculture is granted on the following basis: —

I. The Massachusetts Agricultural College accepts a maximum of four credits in agriculture from any secondary, or county agricultural, high school in Massachusetts offering work in that subject, provided evidence of such work having been done is submitted on a principal's statement, as is indicated in the "free margin" group.

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[1] Note-book required as part of the preparation will be credited as part of the examination.

[2] Examination in September only.

II. In high schools organizing agricultural club work under the supervision and rules of the junior extension service of the college, one credit is granted for each full year of work performed under the following plan: —

Work of the Winter Term. — (*a*) The study of textbooks such as are suitable for secondary school instruction in agriculture.

(*b*) Course of Study: A general outline of suggested topics for study.

(*c*) Visits by a representative of the Massachusetts Agricultural College for observation, counsel and advice in regard to kind and amount of work being done in agriculture.

(*d*) Formation of an agricultural club with officers from among its own members, meeting once a month under local supervision of some one authorized to act for the school authorities.

Work of the Spring Term. — Same in general form as winter term.

Work of the Summer Term. — An approved project conforming to the rules of some one or more of the agricultural clubs of the junior extension service of the Massachusetts Agricultural College.

Work of the Fall Term. — (*a*) An exhibit of work.

(*b*) Reports and story of achievement submitted to the junior extension service of the college.

The maximum number of credits in agriculture is four. The examinations in agriculture are given in September only.

BOTANY. — For one unit of credit in botany, the work outlined in the statement of requirements issued by the College Entrance Examination Board, or its equivalent, will be accepted. This work should occupy one school year and include laboratory and supplementary text-book study. For one-half unit of credit, work that covers the same ground but occupies half the time required for a full unit of credit will be accepted. These requirements are met by such texts as Stevens "Introduction to Botany" and Bergen & Davis' "Principles of Botany." A note-book containing neat, accurate drawings and descriptive records forms part of the requirement for either the half-unit or the one-unit credit, and this note-book must be presented by all applicants for admission upon examination in this subject. The careful preparation of an herbarium is recommended to all prospective students of this college, although the herbarium is not required.

CHEMISTRY. — The entrance examination in chemistry will cover the work outlined by the College Entrance Examination Board as preparatory for college entrance. In general, this consists of a year of high school chemistry from any standard textbook, with laboratory work on the properties of the common elements and their simpler compounds. No particular work is prescribed. The keeping of a note-book is required.

MATHEMATICS. — (*a*) *Required.* — Algebra: The four fundamental operations for rational algebraic expressions; factoring, determination of highest common factor and lowest common multiple by factoring; fractions, including complex fractions; ratio and proportion; linear equations, both numerical and literal, containing one or more unknown quantities; problems depending on linear equations; radicals, including the extraction of the square root of polynominals and numbers; exponents, including the fractional and negative; quadratic equations, both numerical and literal; simple cases of equations with one or more unknown quantities that can be solved by the methods of linear or quadratic equations; problems depending upon quadratic equations; the binominal theorem for positive integral exponents, the formulas for the *n*th term and the sum of the terms of arithmetic and geometric progressions, with applications.

Plane Geometry: The usual theorems and constructions of good textbooks, including the general properties of plane rectilinear figures; the circle and the measurement of angles; similar polygons; areas; regular polygons and the measurement of the circle; the solution of numerous original exercises, including loci problems; applications to the mensuration of lines and plane surfaces.

(*b*) *Elective.* — Solid Geometry: The usual theorems and constructions of good textbooks, including the relations of planes and lines in space; the properties and measurement of prisms, pyramids, cylinders and cones; the sphere and spherical triangle; the solution of numerous original exercises, including loci problems; applications to the mensuration of surfaces and solids.

Plane Trigonometry: A knowledge of the definitions and relations of trigonometric functions and of circular measurements and angles; proofs of the principal formulas and the application of these formulas to the transformation of the trigonometric functions; solution of trigonometric equations, the theory and use of logarithms, and the solution of right and oblique triangles.

PHYSICS. — To satisfy the entrance requirement in physics, the equivalent of at least one unit of work is required. This work must consist of both class-room work and laboratory practice. The work covered in the class-room should be equal to that outlined in Hall & Bergen's "Textbook of Physics" or Millikan & Gale; the laboratory work should represent at least thirty-five experiments involving careful measurements, with accurate recording of each in laboratory note-book. This note-book, certified by the instructor in the subject, must be submitted by each candidate presenting himself for examination in physics; credit for passing the subject will be given on laboratory notes and on the examination paper submitted. Candidates entering on certificate will not be required to present note-books, but the principal's certification must cover laboratory as well as class-room work.

PHYSIOLOGY. — Hough & Sedgwick's "The Human Mechanism;" Martin's "The Human Body; Briefer Course."

ZOÖLOGY, PHYSICAL GEOGRAPHY, GEOLOGY. — The following suggestions are made concerning preparation for admission in the subjects named above: —

For physiography, Davis' "Elementary Physical Geography;" Gilbert & Brigham's "Introduction to Physical Geography." For zoölogy, textbooks entitled "Animals" or "Animal Studies," by Jordan, Kellogg and Heath; Linville & Kelley's "A Textbook in General Zoölogy." For geology, A. P. Brigham's "A Textbook of Geology" or Tarr's "Elementary Geology."

Applicants for examination in zoölogy are *required* to present certified laboratory note-books; applicants for examination in the other subjects are *advised* to present note-books, if laboratory work has been done. Good note-books may be given credit for entrance. Examination in these subjects will be general, in recognition of the different methods of conducting courses; but students will be examined on the basis of the most thorough secondary school courses.

HISTORY. — The required unit must be offered in either ancient history, medieval and modern history, English history, general history, or United

States history and civics. Either one, two or three elective units in any of the historical subjects here named may be offered, provided that no unit be offered in the same subject in which the required unit has been offered.

Preparation in history will be satisfactory if made in accordance with the recommendations of the committee of seven of the American Historical Association, as outlined by the College Entrance Examination Board. The examination will require comparisons and the use of judgment by the candidate rather than the mere use of memory, and it will presuppose the use of good textbooks, collateral reading and practice in written work. Geographical knowledge may be tested by requiring the location of places and movements on outline maps.

To indicate in a general way the character of the text-book work expected, the texts of the following authors are suggested: Botsford, Morey or Myers, in ancient history (to 814 A.D.); Adams, West or Myers, in medieval history; Montgomery, Larned or Cheyney, in English history; Myers or Fisher, in general history; Fiske, together with MacLaughlin or Montgomery, in United States history and civics.

English. — The study of English in school has two main objects, which should be considered of equal importance: (1) command of correct and clear English, spoken and written; (2) ability to read with accuracy, intelligence and appreciation, and the development of the habit of reading good literature with enjoyment.

(1) *Grammar and Composition* (One and One-half Units). — The first object requires instruction in grammar and composition. English grammar should ordinarily be reviewed in the secondary school; and correct spelling and grammatical accuracy should be rigorously exacted in connection with all written work during the four years. The principles of English composition governing punctuation, the use of words, sentences and paragraphs should be thoroughly mastered; and practice in composition, oral as well as written, should extend throughout the secondary school period. Written exercises may well comprise letter-writing, narration, description and easy exposition and argument. It is advisable that subjects for this work be taken from the student's personal experience, general knowledge and studies other than English, as well as from his reading in literature. Finally, special instruction in language and composition should be accompanied by concerted effort of teachers in all branches to cultivate in the student the habit of using good English in his recitations and various exercises, whether oral or written.

(2) *Literature* (One and One-half Units). — The second object is sought by means of two lists of books, headed, respectively, "Reading" and "Study," from which may be framed a progressive course in literature covering four years. In connection with both lists the student should be trained in reading aloud and encouraged to commit to memory some of the more notable passages both in verse and in prose. As an aid to literary appreciation, he is further advised to acquaint himself with the most important facts in the lives of the authors whose works he reads and with their place in literary history.

A. Books for Reading. — The aim of this course is to foster in the student the habit of intelligent reading and to develop a taste for good literature by giving him a first-hand knowledge of some of its best specimens. He should read the books carefully, but his attention should not be so fixed upon details that he fails to appreciate the main purpose and charm of what he reads.

The books provided for reading are arranged in the following groups, from each of which at least two selections are to be made, except that for any book in Group I. a book from any other may be substituted.

GROUP I. CLASSICS IN TRANSLATION.

The "Old Testament," at least the chief narrative episodes in Genesis, Exodus, Joshua, Judges, Samuel, Kings and Daniel, together with the books of Ruth and Esther.
The "Odyssey," with the omission, if desired, of Books I–V, XV and XVI.
The "Æneid."
The "Odyssey" and the "Æneid" should be read in English translations of recognized literary excellence.

GROUP II. DRAMA.

Shakespeare: "Merchant of Venice," "As You Like It," "Julius Cæsar."

GROUP III. PROSE FICTION.

Dickens: "A Tale of Two Cities."
George Eliot: "Silas Marner."
Scott: "Quentin Durward."
Hawthorne: "The House of the Seven Gables."

GROUP IV. ESSAYS, BIOGRAPHY, ETC.

Addison and Steele: "The Sir Roger de Coverly Papers."
Irving: "The Sketch Book," selections covering about 175 pages.
Macaulay: "Lord Clive."
Parkman: "The Oregon Trail."

GROUP V. POETRY.

Tennyson: "The Coming of Arthur," "Gareth and Lynette," "Lancelot and Elaine," "The Passing of Arthur."
Browning: "Cavalier Tunes," "The Lost Leader," "How They Brought the Good News from Ghent to Aix," "Home Thoughts from Abroad," "Home Thoughts from the Sea," "Incident of the French Camp," "Herve Riel," "Pheidippides," "My Last Duchess," "Up at a Villa—Down in the City," "The Italian in England," "The Patriot," "The Pied Piper," "De Gustibus," "Instans Tyrannus."
Scott: "The Lady of the Lake."
Coleridge: "The Ancient Mariner."
Arnold: "Sohrab and Rustum."

B. Books for Study. — This part of the requirement is intended as a natural and logical continuation of the student's earlier reading, with greater stress laid upon form and style, the exact meaning of words and phrases, and the understanding of allusions. The books provided for study are arranged in four groups, from each of which one selection is to be made.

The books provided for study are arranged in four groups, from each of which one selection is to be made.

GROUP I. DRAMA.

Shakespeare: "Macbeth," "Hamlet."

GROUP II. POETRY.

Milton: "L'Allegro," "Il Penseroso," "Comus."
Book IV of Palgrave's "Golden Treasury" (first series), with special attention to Wordsworth, Keats and Shelley.

GROUP III. ORATORY.

Burke: "Speech on Conciliation with America."

Washington's "Farewell Address," Webster's "First Bunker Hill Oration," and Lincoln's "Gettysburg Address."

GROUP IV. ESSAYS.

Macaulay: "Life of Johnson."

Carlyle: "Essay on Burns;" with a brief selection from Burns' poems.

Examination. — However accurate in subject-matter, no paper will be considered satisfactory if seriously defective in punctuation, spelling or other essentials of good usage.

The examination will be divided into two parts, one of which will be on grammar and composition, and the other on literature.

In grammar and composition, the candidate may be asked specific questions upon the practical essentials of these studies, such as the relation of the various parts of a sentence to one another, the construction of individual words in a sentence of reasonable difficulty, and those good usages of modern English which one should know in distinction from current errors. The main test in composition will consist of one or more essays, developing a theme through several paragraphs; the subjects will be drawn from the books read, from the candidate's other studies and from his personal knowledge and experience quite apart from reading.

The examination in literature will include: —

(*a*) General questions designed to test such a knowledge and appreciation of literature as may be gained by fulfilling the requirements defined under "A, Reading," above.

(*b*) A test on the books prescribed for study, which will consist of questions upon their content and structure, and upon the meaning of such words, phrases and allusions as may be necessary to an understanding of the works and an appreciation of their salient qualities of style. General questions may also be asked concerning the lives of the authors, their works and the periods of literary history to which they belong.

FRENCH. — Elementary: The necessary preparation for this examination is stated in the description of the two-year course in elementary French recommended by the Modern Language Association, contained in the definition of requirements of the College Entrance Examination Board.

Third and fourth year French (elective subjects for admission). — For a third credit unit in French as an elective subject for entrance, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in French will be given unless the candidate has presented elementary French on certificate, or has written the examination in elementary French.

No examination for a fourth credit in French will be given unless the candidate has presented both elementary and intermediate French upon certificate, or has written the examination in both elementary and intermediate French.

GERMAN. — Elementary: The entrance requirements in German conform to those of the College Entrance Examination Board for elementary German (the standard two-year requirements).

Third and fourth year German (elective subjects for admission). — For a third credit unit in German as an elective subject for entrance, when required units have been offered in German, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in German will be given unless the candidate has presented elementary German upon certificate, or has written the examination in elementary German.

No examination for a fourth credit in German will be given unless the candidate has presented both elementary and intermediate German upon certificate, or has written the examination for both elementary and intermediate German.

Spanish. — Elementary: The necessary preparation for this examination is stated in the description of the two-year course in elementary Spanish recommended by the Modern Language Association, contained in the definition of requirements of the College Entrance Examination Board.

Third and fourth year Spanish (elective subjects for admission). — For a third credit unit in Spanish as an elective subject for entrance, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in Spanish will be given unless the candidate has presented elementary Spanish on certificate, or has written the examination in elementary Spanish.

No examination for a fourth credit in Spanish will be given unless the candidate has presented both elementary and intermediate Spanish upon certificate, or has written the examination in both elementary and intermediate Spanish.

Greek. — *Elementary.* — Greek grammar and composition: Translation into Greek of short sentences illustrating common principles of syntax.

The examination in grammar and prose composition will be based on the first four books of Xenophon's "Anabasis."

Intermediate. — Homer's "Iliad," Books I and II (omitting Book II, 494 to end), and the Homeric forms, constructions, idioms and prosody.

Prose composition, consisting of continuous prose based on Xenophon, and other Attic prose of similar difficulty.

Translation of passages of Homer at sight.

The examinations in Greek, elementary and intermediate, will be given in September only.

Latin. — *Elementary.* — Two credit units will be allowed if satisfactory proficiency is shown (including grammar) in (*a*) the translation of a passage or passages taken from Cæsar's "Gallic War," covering at least four books, and (*b*) the translation of passages of Latin prose at sight.

Intermediate. — Cicero (third oration "Against Catiline" and the orations "For Archias" and "For Marcellus") and sight translation of prose.

Advanced. — Vergil (Æneid, II, III and VI) and sight translation of poetry.

E. Admission to Advanced Standing.

Candidates for admission to advanced standing, in addition to meeting the regular entrance requirements, must also pass examinations in those subjects already pursued by the class they desire to enter. To meet this requirement, a student transferring to this college from another college or university of recognized standing must present the following credentials: —

1. A letter of honorable dismissal from the institution with which he has been connected.
2. A statement or certificate of his entrance record.
3. A statement from the proper officer showing a complete record of his work while in attendance.
4. A marked catalogue showing the courses pursued.
5. A statement from the proper officer, giving the total number of credits required for graduation by the institution from which the applicant is transferring, and, of this total, the number that the applicant has satisfactorily completed at the time of transfer.

These credentials should be presented to the registrar. Applications will be judged wholly on their merits and the college may prescribe additional tests before accepting applicants or determining the standing to be granted them.

F. Other Information about Entrance.

1. The privileges of the college may be withdrawn from any student at any time if such action is deemed advisable. (It is immaterial whether the pupil has entered by certificate or by examination.)
2. The examination in each subject may be either oral or written, or both. The standard required for passing an entrance examination is 65 per cent.
3. To matriculate, candidates must offer twelve and one-half of the fourteen and one-half units required for admission, and will be conditioned in those subjects not passed. At least five and one-half credits must be in the prescribed group. No candidate deficient in both algebra and plane geometry will be admitted.
4. Examinations for the removal of entrance conditions will be held as follows: (1) First entrance condition examination during the first week of the second term. (2) Second entrance condition examination before the beginning of the period of final examinations of the second term, upon the payment of a fee of $5 to the treasurer.
5. Credits for entrance requirements, whether gained by certificate or by examination, will hold good for one year.
6. Examinations in part of the subjects required for entrance may be taken one year before entering college.
7. For information concerning expenses, scholarships, etc., see "General Information."
8. For information concerning admission to short courses, see "Short Courses."
9. Application for admission as a "Special Student" should be made to the Dean.

COURSES OF INSTRUCTION.

TABLE OF FRESHMAN AND SOPHOMORE SUBJECTS.

[The figures indicate the number of credit hours a week. For details, see the descriptions of courses.]

FRESHMAN YEAR.

FIRST TERM.

All work required.

SUBJECT.	Courses and Numbers.	Credit Hours per Week.
Chemistry,	Chemistry 1 or 4,	3
Algebra,	Mathematics 1,	5
Language,	French or German 1 or 4,	3
English,	English 1,	3
Agriculture,	Agronomy 1, Horticulture 1,	3
Tactics (for men),	Military 1,	1
Drill (for men),	Military 4,	1
Microbiology (for women),	Microbiology 1,	3
Hygiene,	Physical Education 1,	1
Public speaking,	Public Speaking 1 (one-third of the class),	1

College life (attendance without credit).

SECOND TERM.

SUBJECT.	Courses and Numbers.	Credit Hours per Week.
Chemistry,	Chemistry 2 or 5,	3
Algebra,	Mathematics 2,	2
Trigonometry,	Mathematics 5,	3
Language,	French or German 2 or 5,	3
English,	English 2,	3
Agriculture,	Poultry 1, Animal Husbandry 1,	3
Tactics (for men),	Military 2,	1
Drill (for men),	Military 5,	1
Geology (for men),	Geology 2,	2
Rural home life (for women),	Rural Home Life 2,	2
Public speaking,	Public Speaking 1 (one-third of class),	1

College life (attendance without credit).

FRESHMAN YEAR — *Concluded.*

THIRD TERM.

SUBJECT.	Courses and Numbers.	Credit Hours per Week.
Chemistry,	Chemistry 3 or 6,	3
Solid geometry,	Mathematics 3,	3
Mensuration (for men),	Mathematics 6,	2
Language,	French or German 3 or 6,	3
English,	English 3,	3
Botany,	Botany 3,	3
Tactics (for men),	Military 3,	1
Drill (for men),	Military 6,	1
Microbiology (for women),	Microbiology 3,	2
Rural home life (for women),	Rural Home Life 3,	3
Recreation,	Physical Education 3,	1
Public speaking,	Public Speaking 1 (one-third of class),	1

College life (attendance without credit).

SOPHOMORE YEAR.

FIRST TERM.

SUBJECT.	Course Number.	Class Hours.	Two Hour Laboratory Periods.	Credit Hours per Week.
Required.				
Physics,	25	3	1	4
Zoölogy,	25	2	2	4
Botany,	25	1	2	3
English,	25	2	–	2
Military (for men),	25	1	–	1
Military (for men),	28	–	2	1
Microbiology (for women),	25	2	–	2
Total required,	–	–	–	17
Elective.				
Chemistry,	25	1	2	3
French,	25 or 28	3	–	3
German,	25 or 28	3	–	3
Drawing,	25	–	3	3
Animal husbandry,	25	2	1	3
Rural engineering,	25	–	2	2
Rural home life,	25	1	2	3

Minimum credit for first term, 18.
Maximum credit for first term, 21.

SECOND TERM.

Required.				
Physics,	26	2	1	3
Agricultural economics,	26	5	–	5
English,	26	2	–	2
Military (for men),	26	1	–	1
Military (for men),	29	–	2	1
Total required,	–	–	–	12
Elective.				
Chemistry,	26	1	2	3
French,	26 or 29	3	–	3
German,	26 or 29	3	–	3
Mathematics,	26	2	–	2
Drawing,	26	–	3	3
Entomology,	26	3	–	3
Animal husbandry,	26	2	1	3
Rural engineering,	26	–	2	2
Botany,	26	1	2	3
Economic sociology,	26	5	–	5
Rural home life (for women),	26	1	2	3

Minimum credit for second term, 18.
Maximum credit for second term, 20.

SOPHOMORE YEAR — *Concluded.*

THIRD TERM.

SUBJECT.	Course Number.	Class Hours.	Two-Hour Laboratory Periods.	Credit Hours per Week.
Required.				
Rural sociology,	27	3	–	3
Agronomy,	27	4	1	5
English,	27	2	–	2
Military (for men),	27	1	–	1
Military (for men),	30	–	2	1
Microbiology (for women),	27	2	–	2
Physical education,[1]	26	–	1	1
Total required,	–	–	–	15
Elective.				
Botany,	27	1	2	3
Chemistry,	27	1	4	5
Chemistry,	30	3	2	5
French,	27 or 30	3	–	3
German,	27 or 30	3	–	3
Mathematics,	27	–	3	3
Drawing,	27	–	3	3
Entomology,	27	–	2	2
Geology,	27	3	2	5
Physics,	27	4	1	5
Horticulture,	27	2	1	3
Zoölogy,	27	1	2	3
Rural home life (for women),	27	1	2	3

Minimum credit for third term, 19.
Maximum credit for third term, 22.

[1] Credit for Physical Education 2 and 3 given in third term.

MAJORS: JUNIOR AND SENIOR YEARS.

General Statement.

A major consists of 45 credit hours of correlated work, to be arranged by the student and an instructor called the adviser.

The list of courses found under each major on subsequent pages should not be considered as necessarily a rigid program to be followed. The heads of departments have suggested this series of courses as the best for the average man majoring in their departments. Advisers may, however, make modifications to suit the particular needs of the student, provided these modifications conform precisely to the class schedule as published for the year.

Rules governing Majors.

Rule 1. *Election.* — Each student, before the first term of his junior year, shall elect a major subject from the list of majors given below; and this major shall consist of 45 credit hours of correlated work.

Rule 2. *Minimum Credits.* — The minimum number of credits for graduation shall be 237 credit hours, inclusive of military drill and physical education.

Rule 3. *Maximum Credits.* — The maximum number of credits for any term of the junior or senior year shall be 22; the minimum shall be 19.

Rule 4. *Humanities and Rural Social Science.* — A minimum of 18 credit hours in the Divisions of the Humanities and Rural Social Science will be required of all students during their junior and senior years, with the following restriction: that a minimum of 5 credit hours will be required in each of the divisions.

Rule 5. *Advisers.* — The work of each junior and senior will be under the immediate supervision of an instructor designated as major adviser. Ordinarily, the major adviser will be the head of the department in which the student intends to elect his major. Each student should consult with the adviser as soon as possible. The adviser has full authority to prescribe the student's work up to 45 hours. It is understood, however, that so far as practicable the individual needs of the student will be recognized. It is also hoped and expected that students will be disposed to seek the counsel of the adviser with respect to the remaining courses required for graduation.

Rule 6. *Free Electives.* — Each student during his junior and senior years is required to take 45 hours in his major and also 18 hours in the Divisions of the Humanities and Rural Social Science, making a total of 63 hours (but see Rule 4). He is allowed free choice of courses to complete his required hours.

Rule 7. *Registration.* — No junior or senior shall register until his major course of study is approved by his adviser.

(1) Course cards for recording the election of majors will be issued from the registrar's office three weeks before the close of each term.

(2) This card must be submitted by each student to his major adviser, who will lay out the course for the succeeding term and countersign the card.

(3) Each course card must be filled out, giving the name of student, his college address, the name of parent or guardian, and the student's home address. When the major courses have been entered on this card, and the hours

of free elections added by the student, the card must be returned to the registrar one week before the beginning of the final examination period.

Rule 8. *Changes.* — Applications for changes may be made to the dean in writing at any time; when approved by him and by the committee on scholarship, they become operative at the beginning of the term following, provided that no change in the selection of a major may be made by any student after registration day of his senior year.

AGRICULTURE. (Major.)

Professor JAMES A. FOORD, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agronomy,	50 **I.**	5	**I.**	Animal Husbandry 25,	3	Agronomy 50,	5	Rural Engineering 75,	5
Animal Husbandry,	53 **III.**	3		Rural Engineering 25,	2	Dairying 50 (or 77),	5	Farm Management 75,	3
						Animal Husbandry 50,	3	Farm Management 76,	3
Animal Husbandry,	50 **I.**	3	**II.**	Animal Husbandry 26,	3	Animal Husbandry 51,	3	Farm Management 78,	1
Animal Husbandry,	51 **II.**	3		Rural Engineering 26,	2				
Dairying,	50 **I.**	5							
Farm Management,	75 **I.**	3	**III.**	Chemistry 30,	5	Microbiology 50,	5	Farm Management 77,	3
Farm Management,	76 **I.**	3		Horticulture 27,	3	Animal Husbandry 53,	3	Farm Management 79,	1
Farm Management,	77 **III.**	3						Rural Engineering 78,	3
Farm Management,	78 **II.**	1						Rural Engineering 79,	5
Farm Management,	79 **III.**	1							
Microbiology,	50 **I.**								
or									
Microbiology,	50 **III.**	5	**IV.**						
Rural Engineering,	75 **I.**	5							
Rural Engineering,	78 **III.**	3							
Rural Engineering,	79 **III.**	5							
		48							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Animal Husbandry 25 and 26, Rural Engineering (shop work) 25 and 26, Chemistry 30 or Chemistry 6, Freshman, and Horticulture 27.

ADDITIONAL INFORMATION. — Botany 26, Drawing 26, Entomology 26 and 27, Dairying 75, Pomology 50, 51, 52 and 78, and Veterinary 51, 75 and 78 are suggested as additional courses for the student fitting himself for general agriculture.

AGRONOMY. (Major.)

Professor ARTHUR B. BEAUMONT, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agronomy,	50 **I.**	5	**I.**	Chemistry 25,	3	Agronomy 50,	5	Agronomy 75,	5
Agronomy,	51 **III.**	3		German 25 or 28,	3	Chemistry 51,	8	Farm Management 76,	3
Agronomy,	75 **I.**	5				Animal Husbandry 50,	3		
Agronomy,	77 **II.**	5	**II.**	Botany 26,	3	Chemistry 52,	8	Agronomy 77,	5
Animal Husbandry.	50 **I.**	3		Chemistry 26,	3				
Chemistry,	51 **I.**	8		German 26 or 29,	3				
				Mathematics 26,	2				
Chemistry,	52 **II.**	8	**III.**	German 27 or 30,	3	Agronomy 51,	3	Farm Management 77,	3
Farm Management,	76 **I.**	3		Mathematics 27,	3				
Farm Management,	77 **III.**	3		Geology 27,	5				
		43							
			IV.						

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Chemistry 25 and 26, German 25 or 28, 26 or 29, 27 or 30, Geology 27, Botany 26.
ADVISED. — Mathematics 26 and 27.

ANIMAL HUSBANDRY. (Major.)

Professor S. M. SALISBURY, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agronomy,	50 **I.**	5	**I.**	Animal Husbandry 25,	3	Animal Husbandry 50,	3	Animal Husbandry 75,	3
Animal Husbandry,	51 **II.**	3				Agronomy 50,	5	Farm Management 75,	3
Animal Husbandry,	50 **I.**	3				Veterinary 50,	5	Farm Management 76,	3
						Dairying 50,	5		
Animal Husbandry,	52 **III.**	3	**II.**	Animal Husbandry 26,	3	Animal Husbandry 51,	3	Animal Husbandry 78,	3
Animal Husbandry,	75 **I.**	3							
Animal Husbandry,	53 **III.**	3	**III.**	Chemistry 30,	5	Animal Husbandry 52,	3	Animal Husbandry 80,	1
Animal Husbandry,	78 **II.**	3				Animal Husbandry 53,	3		
Animal Husbandry,	80 **III.**	1							
Dairying,	50 **I.**	5	**IV.**						
Farm Management,	75 **I.**	3							
Farm Management,	76 **I.**	3							
Veterinary,	50 **I.**	5							
		40							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Animal Husbandry 25 and 26, Chemistry 30.

ADDITIONAL INFORMATION. — The balance of the sophomore electives allowed are left to the student to choose.

DAIRYING. (Major.)

Professor WILLIAM P. B. LOCKWOOD, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Animal Husbandry,	52 **III.**	3	**I.**	Animal Husbandry 25,	3	Dairying 50,	5	Microbiology 82,	5
Animal Husbandry,	50 **I.**	3		Rural Engineering 25,	2	Microbiology 50,	5	Farm Management 75,	3
Animal Husbandry,	51 **II.**	3				Animal Husbandry 50,	3		
Dairying,	50 **I.**	5	**II.**	Animal Husbandry 26,	3	Animal Husbandry 51,	3	Dairying 75,	5
Dairying,	51 **III.**	5		Rural Engineering 26,	2	Rural Engineering 77,	5		
Dairying,	75 **II.**	5				Microbiology 51,	5		
						(Prerequisite to 82.)			
Dairying,	76 **III.**	5	**III.**	Chemistry 30,	5	Animal Husbandry 52,	3	Dairying 76,	5
Farm Management,	75 **I.**	3				Dairying 51,	5		
Microbiology,	50 **I.**	5							
Microbiology,	82 **I.**	5							
Microbiology,	51 **II.**	5							
Rural Engineering,	77 **II.**	5	**IV.**						
		52							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Animal Husbandry 25 and 26, Rural Engineering 25 and 26, Chemistry 30.

ADDITIONAL INFORMATION. — The balance of the sophomore electives allowed are left to the student to choose.

POULTRY HUSBANDRY. (Major.)

Professor JOHN C. GRAHAM, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Animal Husbandry,	53 **III.**	3	**I.**			Poultry 50,	3	Poultry 76,	5
Poultry Husbandry,	50 **I.**	3				Poultry 51,	2	Poultry 77,	5
						Pomology 50,	3		
Poultry Husbandry,	51 **I.**	2	**II.**			Poultry 52,	3	Poultry 75,	5
Poultry Husbandry,	52 **II.**	3						Veterinary 86,	3
Poultry Husbandry,	53 **III.**	5						Poultry 55,	1-5
Poultry Husbandry,	55	1-5							
Poultry Husbandry,	54 **III.**	2	**III.**			Poultry 53,	5		
Poultry Husbandry,	75 **II.**	5				Poultry 54,	2		
Poultry Husbandry,	76 **I.**	5				Animal Husbandry 53,	3		
Agricultural Economics,	53 **III.**	5				Agricultural Economics 53,	5		
Poultry Husbandry,	77 **I.**	5	**IV.**						
Pomology,	50 **I.**	3							
Veterinary Science,	86 **II.**	3							
		45–49							

SOPHOMORE RECOMMENDATIONS. — Students intending to major in Poultry Husbandry are urged to take Zoölogy 27.
ADVISED. — Juniors who did not take Zoölogy 27 as sophomores are strongly advised to include it in their program.

FLORICULTURE.

Professor CLARK L. THAYER, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.
Botany,	50 **I.**	2
Botany,	51 **II.**	2
Entomology,	26 **II.**	3
Floriculture,	50 **I.**	4
Floriculture,	51 **II.**	4
Floriculture,	52 **III.**	4
Floriculture,	53 **I.**	3
Floriculture,	54 **II.**	3
Floriculture,	75 **I.**	3
Floriculture,	76 **II.**	3
Floriculture,	77 **II.**	3
Floriculture,	78 **III.**	3
Floriculture,	79 **III.**	3
Floriculture,	80 **III.**	3
Horticulture,	50 **I.**	5
Horticulture,	51 **III.**	5
		53

Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
I.	Drawing 25,	3	Floriculture 50,	4	Floriculture 75,	3
			Floriculture 53,	3	Horticulture 50,	5
			Botany 50,	2		
II.	Drawing 26,	3	Floriculture 51,	4	Floriculture 77,	3
	Entomology 26,	3	Floriculture 54,	3	Floriculture 76,	3
	Botany 26,	3	Entomology 26,	3		
			Botany 51,	2		
III.	Drawing 27,	3	Floriculture 52,	4	Floriculture 79,	3
	Entomology 27,	2	Floriculture 78,	3	Floriculture 80,	3
	Horticulture 27,	3			Horticulture 51,	5
IV.						

SOPHOMORE ELECTIVE PREREQUISITES. — Drawing 25, 26 and 27, Entomology 26 and 27, Botany 26 and Horticulture 27.

ADDITIONAL INFORMATION. — The rest of the sophomore electives allowed are left to the student to choose. Horticulture 50 and 51 will be taken by seniors.

ADVISED. — The department advises all students who major in this subject to take Botany 78, Entomology 50 and Landscape Gardening 75.

FORESTRY. (Major.)

Professor LAWRENCE R. GROSE, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Botany,	50 **I.**	2	**I.**	Drawing 25,	3	Forestry 50,	3	Forestry 75,	5
Botany,	51 **II.**	2		Rural Engineering 25,	2	Landscape Gardening 50,	5		
Entomology,	75 **III.**	4				Horticulture 50,	5		
						Botany 50,	2		
Forestry,	50 **I.**	3	**II.**	Drawing 26,	3	Forestry 51,	3		
Forestry,	51 **II.**	3		Mathematics 26,	2	Botany 51,	2		
Forestry,	53 **III.**	3		Entomology 26,	3	Landscape Gardening 51,	4		
Forestry,	54 **IV.**	5		Botany 26,	3				
Forestry,	75 **I.**	5	**III.**	Drawing 27,	3	Forestry 53,	3	Forestry 78,	3
Forestry,	78 **III.**	3		Mathematics 27,	2	Horticulture 51,	5		
Horticulture,	50 **I.**	5		Entomology 27,	3	Entomology 75,	4		
				Horticulture 27,	3				
Horticulture,	51 **III.**	5	**IV.**			Forestry 54,	5		
Landscape Gardening,	50 **I.**	5							
Landscape Gardening,	51 **II.**	4							
		49							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Drawing 25, 26 and 27 ineering 25, Mathematics 26 and 27, Entomology 26 and 27, Botany 26, Horticulture 27.

ADDITIONAL INFORMATION. — Substitutions according to individual needs ma conference with the adviser.

LANDSCAPE GARDENING. (Major.)

Professor FRANK A. WAUGH, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Floriculture,	78 **III.**	3	**I.**	Drawing 25,	3	Landscape Gardening 50,	5	Landscape Gardening 75,	3
Horticulture,	50 **I.**	5				Horticulture 50,	5	Landscape Gardening 80,	4
Horticulture,	51 **III.**	5							
Landscape Gardening,	50 **I.**	5							
Landscape Gardening,	51 **II.**	4	**II.**	Drawing 26,	3	Landscape Gardening 51,	4	Landscape Gardening 76,	4
Landscape Gardening,	52 **III.**	5		Mathematics 26,	2			Landscape Gardening 81,	4
				Entomology 26,	3				
Landscape Gardening,	75 **I.**	3	**III.**	Drawing 27,	3	Landscape Gardening 52,	5	Landscape Gardening 78 or 79,	3
Landscape Gardening,	76 **II.**	4		Mathematics 27,	3	Horticulture 51,	5	Landscape Gardening 77,	4
Landscape Gardening,	77 **III.**	4		Horticulture 27,	3	Landscape Gardening 78 or 79,	3	Landscape Gardening 82,	4
								Floriculture 78,	3
Landscape Gardening,	78 **III.**	3	**IV.**						
or									
Landscape Gardening,	79 **III.**	3							
Landscape Gardening,	80 **I.**	4							
Landscape Gardening,	81 **II.**	4							
Landscape Gardening,	82 **III.**	4							
		56							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Drawing 25, 26 and 27, Mathematics 26 and 27, Horticulture 27.

ADDITIONAL INFORMATION. — Modifications may be permitted when they appear advisable.

POMOLOGY. (Major.)

Professor FRED C. SEARS, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agronomy,	75 **I.**	5	**I.**			Pomology 50,	3	Pomology 75,	3
Horticultural Manufactures,	75 **I.**	5				Agronomy 75,	5	Pomology 77,	5
Vegetable Gardening,	50 **I.**	3				Farm Management 75,	3	Pomology 80,	1
						Vegetable Gardening 50,	3	Horticultural Manuf. 75,	5
Pomology,	50 **I.**	3	**II.**			Pomology 51,	3	Pomology 76,	3
Farm Management,	75 **I.**	3				Rural Engineering 77,	5	Pomology 81,	1
Horticultural Manufactures,	76 **II.**	3						Horticultural Manuf. 76,	3
Pomology,	51 **II.**	3	**III.**	Horticulture 27,	3	Pomology 52,	3	Pomology 78,	3
Pomology,	52 **III.**	3				Agricultural Economics 53,	5	Pomology 82,	1
Pomology,	75 **I.**	3							
Agricultural Economics,	53 **III.**	5							
Rural Engineering,	77 **II.**	5							
Pomology,	76 **II.**		**IV.**						
Pomology,	77 **I.**								
Pomology,	78 **III.**								
Pomology,	80 **I.**								
Pomology,	81 **II.**								
Pomology,	82 **III.**								
		41							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Horticulture 27.

ADVISED. — Rural Engineering 26, Entomology 26 and 27.

ADDITIONAL INFORMATION. — The rest of the sophomore electives allowed are left to the student to choose.

VEGETABLE GARDENING. (Major.)

Associate Professor A. L. DACY, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.
Agronomy,	75 **I.**	5
Agronomy,	77 **II.**	5
Botany,	50 **I.**	2
Botany,	51 **II.**	2
Vegetable Gardening,	51 **I.**	3
Vegetable Gardening,	52 **II.**	3
Vegetable Gardening,	53 **III.**	3
Vegetable Gardening,	54 **IV.**	5
Vegetable Gardening,	75 **I.**	5
Vegetable Gardening,	76 **II.**	5
Vegetable Gardening,	77 **III.**	5
Vegetable Gardening,	78	1
Vegetable Gardening,	79	1
Vegetable Gardening,	80	1
		46

Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
I.			Vegetable Gardening 51, Botany 50,	3 2	Vegetable Gardening 75, Agronomy 75, Vegetable Gardening 78,	5 5 1
II.	Botany 26,	3	Vegetable Gardening 52, Botany 51,	3 2	Vegetable Gardening 76, Vegetable Gardening 79, Agronomy 77,	5 1 5
III.	Horticulture 27,	3	Vegetable Gardening 53,	3	Vegetable Gardening 77, Vegetable Gardening 80,	5 1
IV.			Vegetable Gardening 54,	5		

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Botany 26, Horticulture 27.

ADVISED. — Rural Engineering 26, Entomology 26 and 27.

ADDITIONAL INFORMATION. — The rest of the sophomore electives allowed are left to the student to choose.

ECONOMIC BOTANY. (Major.)

Professor A. VINCENT OSMUN, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.
Botany,	52 **I.**	3
Botany,	53 **II.**	3
Botany,	54 **III.**	3
Botany,	55 **I.**	3
Botany,	56 **II.**	3
Botany,	75 **I.**	5
Botany,	76 **II.**	5
Botany,	77 **III.**	5
Botany,	78 **I.**	5
Botany,	79 **II.**	5
Botany,	80 **III.**	5
Botany,	82 **II.**	3
Botany,	83 **III.**	3
Botany,	86 **I.**	1
Botany,	87 **II.**	1
Botany,	88 **III.**	1
Chemistry,	51 **I.**	8
		62

Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
I.	Chemistry 25,	3	Botany 52,	3	Botany 75,	5
	German 25 or 28,	3	Botany 55,	3	Botany 78,	5
			Chemistry 51,	8	Botany 86,	1
II.	Chemistry 26,	3	Botany 53,	3	Botany 76,	5
	German 26 or 29,	3	Botany 56,	3	Botany 79,	5
	Botany 26,	3			Botany 82,	3
					Botany 87,	1
III.	German 27 or 30,	3	Botany 54,	3	Botany 77,	5
	Botany 27,[1]	3			Botany 80,	5
					Botany 83,	3
					Botany 88,	1
IV.						

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — German 25 or 28, 26 or 29, 27 or 30, Botany 26.

ADVISED. — Chemistry 25 and 26.

ADDITIONAL INFORMATION. — The balance of the sophomore electives allowed are left to the student to choose. Selection of 45 credits of the above (Pathology 75, 76 and 77, Physiology 78, 79 and 80).

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[1] May be taken in junior or senior year.

AGRICULTURAL CHEMISTRY. (Major.)

Professor CHARLES A. PETERS, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Chemistry,	51 **I.**	8	**I.**	Chemistry 25,	3	Chemistry 51,	8	Chemistry 76,	5
Chemistry,	52 **II.**	8						Chemistry 80,	5
Chemistry,	62 **III.**	5							
Chemistry,	65 **III.**	5	**II.**	Chemistry 26,	3	Chemistry 52,	8	Chemistry 77,	3
Chemistry,	76 **I.**	5						Chemistry 90, 92, 94,	3
Chemistry,	77 **II.**	5							
Chemistry,	80 **I.**	5							
Chemistry,	87 **III.**	3							
Chemistry,	90 **II.**	3[1]							
Chemistry,	92 **II.**								
Chemistry,	94 **II.**								
Chemistry,	91 **III.**	5	**III.**	Chemistry 27,	5	Chemistry 62,	5	Chemistry 91, 93, 95,	5
Chemistry,	93 **II.**					Chemistry 65,	5	Chemistry 87,	3
Chemistry,	95 **III.**								
		50[2]							
			IV.						

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Chemistry 25, 26 and 27.

ADVISED. — German 25 or 28, 26 or 29, 27 or 30, Physics 27.

ADDITIONAL INFORMATION. — The balance of the sophomore electives allowed are left for the student to choose.

[1] Courses 90, 92, 94 may be changed from 3 credits to an option of 3 or 5 credits. Students will select one course from groups 90, 92, 94, and 91, 93, 95 respectively.

[2] Only 45 credits required.

ECONOMIC ENTOMOLOGY. (Major.)

Professor HENRY T. FERNALD, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Botany,	50 **I.**	3	**I.**	French 25 or 28,		Entomology 50,	3	Entomology 76,	5
or				or	3	Entomology 53,	5	Vegetable gardening 50,	3
Botany,	52 **I.**	3		German 25 or 28,		Botany 50 or 52,	3	Horticulture 50,	5
Entomology,	50 **I.**	3		Chemistry 25,	3	Zoölogy 50 or 53,	3		
Entomology,	52 **II.**	3				or			
						Chemistry 51,	8		
Entomology,	53 **I.**	5	**II.**	French 26 or 29,		Entomology 52,	3	Entomology 77,	3
Entomology,	54 **II.**	3		or	3	Entomology 54,	3	Entomology 90,	3
Entomology,	55 **III.**	3		German 26 or 29,		Microbiology 50,	5		
Entomology,	75 **III.**	4		Entomology 26,	3				
Entomology,	76 **I.**	5		Botany 26,	3				
Entomology,	77 **II.**	3	**III.**	French 27 or 30,		Entomology 55,	3	Entomology 78,	4
Entomology,	78 **III.**	4		or	3	Entomology 75,	4	Horticulture 51,	5
Entomology,	90 **II.**	3		German 27 or 30,		Horticulture 27,	3	Pomology 78,	3
				Entomology 27,	2	Pomology 79,	3		
Zoölogy,	50 **I.**	3	**IV.**						
or									
Zoölogy,	53 **I.**	3							
or									
Chemistry,	51 **I.**	8							
		42 or 47							

SOPHOMORE ELECTIVE PREREQUISITES (REQUIRED). — Entomology 26 and 27, Botany 26.

ADVISED. — French or German 25 to 27 or 28 to 30, Chemistry 25; the other subjects (except Entomology) in the last three columns above are merely suggested as desirable to choose from.

MICROBIOLOGY. (Major.)

Professor CHARLES E. MARSHALL, *Adviser*.

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit
Chemistry,	51 **I.**	8
Chemistry,	52 **II.**	8
Microbiology, or	50 **I.**	5
Microbiology, or	50 **II.**	
Microbiology,	50 **III.**	
Microbiology, or	51 **II.**	5
Microbiology,	51 **III.**	
Microbiology,	52 **III.**	5
Microbiology, or	81 **I.**	5
Microbiology, or	82 **I.**	
Microbiology,	83 **I.**	
Microbiology, or	80 **II.**	5
Microbiology, or	75 **II.**	
Dairying,	75 **II.**	
Microbiology,	76 **III.**	5
		46

Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
I.	Chemistry 25,	3	Microbiology 50,	5	Microbiology 81,	5
	German or French 25 or 28,	3	Chemistry 51,	8	Microbiology 82,	5
					Microbiology 83,	5
II.	German or French 26 or 29,	3	Microbiology 51,	5	Microbiology 75,	5
			Chemistry 52,	8	Microbiology 80,	5
			Microbiology 50,	5	Dairying 75,	5
III.	Chemistry 27,	5	Microbiology 50,	5	Microbiology 76,	5
	German or French 27 or 30,	3	Microbiology 51,	5		
	Physics 27,	5	Microbiology 52,	5		
IV.						

SOPHOMORE ELECTIVE (RECOMMENDATIONS). — German or French 25 or 28, 26 or 29, 27 or 30, Chemistry 25 and 27, and Physics 27.

ADDITIONAL INFORMATION. — The rest of the sophomore electives allowed are left for the student to choose. Microbiology 51, fall term, will be taken by students who have had Microbiology 50 at any previous time and by those who are permitted to omit Microbiology 50.

RURAL JOURNALISM. (Major.)

——. *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Rural Journalism,	50 **I.**	3	**I.**			Journalism 50,	3	Journalism 77,	3
Rural Journalism,	51 **II.**	3				Journalism 53,	3	Journalism 80,	4 (5)
Rural Journalism,	52 **III.**	3				Economics and Sociology 51,	5		
Two out of three: —									
Rural Journalism,	53 **I.**	3	**II.**	Economics and Sociology 26,	5	Journalism 51,	3	Journalism 78,	3
Rural Journalism,	54 **II.**	3				Journalism 54,	3	Journalism 81,	4 (5)
Rural Journalism,	55 **III.**	3							
Two out of three: —									
Rural Journalism,	77 **I.**	3	**III.**			Journalism 55,	3	Journalism 79,	3
Rural Journalism,	78 **II.**	3				Journalism 52,	3	Journalism 82,	4 (5)
Rural Journalism,	79 **III.**	3				Agricultural Economics 51,	5		
One from: —									
Entomology,	90 **II.**	3							
or									
Animal Husbandry,	53 **III.**								
Landscape,	75 **I.**								
Chemistry,	87 **III.**								
All: —									
Rural Journalism,	80 **I.**	4 (5)							
Rural Journalism,	81 **II.**	4 (5)							
Rural Journalism,	82 **III.**	4 (5)							
Rural Sociology,	78 **II.**	5	**IV.**						
Agricultural Economics,	51 **III.**	5							
Economics and Sociology,	51 **I.**	5							
		45–47							

SOPHOMORE PREREQUISITES. — All sophomore English.

SOPHOMORE RECOMMENDATIONS. — French or German; Drawing 25. *For agricultural journalism especially:* Animal Husbandry 25, 26, Chemistry 30, Entomology 26, 27.

AGRICULTURAL ECONOMICS. (Major.)

Professor ALEXANDER E. CANCE, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agricultural Economics,	50 **I.**	5	**I.**			Agricultural Economics 50,	5	Agricultural Economics 77,	5
Agricultural Economics,	52 **II.**	5				Economic Sociology 51,	5	Agricultural Economics 79,	5
Agricultural Economics,	53 **III.**	5						Farm Management 76,	3
Agricultural Economics,	78 **III.**	3							
Agricultural Economics,	76 **II.**	5	**II.**			Agricultural Economics 52,	5	Agricultural Economics 76,	5
Agricultural Economics,	79 **I.**					Rural Sociology 51,	3	Rural Sociology 78,	5
or		5				Economic Sociology 50,	5		
Agricultural Economics,	77 **I.**								
Economic Sociology,	51 **I.**	5							
Economic Sociology,	50 **II.**	5	**III.**			Rural Sociology 52,	3	Agricultural Economics 78,	3
Farm Management,	76 **I.**	3				Agricultural Economics 53,	5		
Rural Sociology,	51 **II.**								
or		3							
Rural Sociology,	52 **III.**		**IV.**						
Rural Sociology,	78 **II.**	5							
		49							

ADDITIONAL INFORMATION. — The sophomore electives are left to the student to choose. Animal husbandry is suggested for terms I. and II., and Economic Sociology for term III.

AGRICULTURAL EDUCATION. (Major.)

Professor WILLIAM R. HART, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.
Agricultural Education (Educational Psychology).	50 **I.**	5
Agricultural Education (Principles of Teaching).	51 **I., II., III.**	5
Agricultural Education (History and Philosophy).	52 **III.**	5
Agricultural Education (Secondary Education).	75 **I.**	3
Agricultural Education (Methods in Vocational Agriculture).	76 **I.**	3
Agricultural Education (Methods in Vocational Agriculture).	76 **II.**	3
Agricultural Education (Methods in Vocational Agriculture).	76 **III.**	3
Agricultural Education (county agent work).	77 **II.**	5
Agricultural Education (county agent work).	77 **III.**	5
Agricultural Education (apprentice teaching).	80 **I.**	1–5
Agricultural Education (apprentice teaching).	80 **II.**	1–5
Agricultural Education (apprentice teaching).	80 **III.**	1–5
Agricultural Education (apprentice teaching).	80 **IV.**	1–5

Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
I.	Animal Husbandry 25,	3	Agricultural Education 50,	5	Agricultural Education 75,	3
	Rural Engineering 25,	2	Agricultural Education 51,	5	Agricultural Education 80,	1–5
					Agricultural Education 76,	3
II.	Entomology 26,	3	Agricultural Education 51,	5	Agricultural Education 76,	3
	Rural Engineering 26,	2			Agricultural Education 77,	5
	Animal Husbandry 26,	3			Agricultural Education 80,	1–5
III.	Entomology 27,	3	Agricultural Education 52,	5	Agricultural Education 76,	3
	Horticulture 27,	3	Agricultural Education 51,	5	Agricultural Education 77,	5
					Agricultural Education 80,	1–5
IV.	Courses available in the Summer School: Agricultural Education 51, 75, 76, 80, and special courses leading to positions as supervisors and directors of agricultural teaching and to college positions in Agricultural Education.					

ADDITIONAL INFORMATION. — Courses 50, 51, 76 and 80 or their equivalents are required of all candidates for teaching; credits vary from 14 to 18. Courses 51 and 77 are required of all candidates for county agent work. Students who are intending to teach are recommended to take as many of the sophomore electives listed above as possible in the sophomore year. Programs for juniors and seniors are planned on the basis of individual needs, with a view to the most desirable preparation for the attainment of the student's aim. Some of the aims for which programs are planned are as follows: teaching vocational agriculture; teaching non-agricultural subjects in vocational agricultural schools and departments; teaching agriculture in high schools not of the vocational type; county agent work and Junior Extension work; directing physical education and county Y. M. C. A. work; rural school supervision and rural leadership; positions as supervisors and directors of agricultural teaching; and college positions in Agricultural Education.

RURAL SOCIOLOGY. (Major.)

Professor JOHN PHELAN, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

COURSE.	Number.	Credit.	Term.	Sophomore.	Credit.	Junior.	Credit.	Senior.	Credit.
Agricultural Economics,	50 **I.**	5	**I.**			Agricultural Economics 50,	5	Economics and Sociology 75,	5
Agricultural Economics,	52 **II.**	5				Rural Sociology 50,	3		
Economics and Sociology,	51 **I.**	5				Economic Sociology 51,	5		
Economics and Sociology,	75 **I.**	5							
Economic Sociology,	77 **III.**	5	**II.**			Rural Sociology 51,	3	Rural Sociology 77,	3
Rural Journalism,	55 **III.**	3				Agricultural Economics 52,	5	Rural Sociology 78,	5
						Agricultural Education 52,	5		
Rural Sociology,	50 **I.**	3	**III.**			Rural Journalism 55,	3	Economic Sociology 77,	5
Rural Sociology,	52 **III.**	3				Rural Sociology 52,	3		
Rural Sociology,	51 **II.**	3							
Rural Sociology,	77 **II.**	3	**IV.**						
Agricultural Education, or Rural Sociology,	52 **II.** 78 **II.**	5							
		45							

ADDITIONAL INFORMATION. — The sophomore electives allowed are left to the student to choose.

DESCRIPTION OF COURSES

DESCRIPTION OF COURSES.

DIVISION OF AGRICULTURE.

Professor FOORD.

[Heavy-faced Roman numerals indicate the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

AGRICULTURE AND HORTICULTURE. Freshmen. This course continuing through the year constitutes the required elementary work dealing with the foundations of the subjects of live stock and the crops of the field, orchard and the garden. Several departments collaborate in giving the work; three credits each term are assigned to this course. For a description of the work see —

Agronomy 1, **I.**
Animal Husbandry 1, **II.**
Horticulture 1, I.
Poultry Husbandry 1, **II.**

Agronomy.

Professor BEAUMONT, Assistant Professor ——, Mr. THELIN, Mr. THAYER.

The courses in agronomy are designed to give the student fundamental knowledge concerning the soil and the principal products of the field. The basic course in soils is required of all students. The electives purpose to meet the needs of those specializing in soils and field crops and other specialized fields including both pure and applied science.

The laboratories for soils and fertilizers include one for elementary work, supplied with locker equipment for 200 students, and one for advanced work, accommodating 80 students. These laboratories are equipped with steam and electric ovens, balances, centrifuge, microscopes and other apparatus necessary for a study of soils and fertilizers. Storerooms, stock rooms, and balance rooms are located convenient to the laboratories. There is also a workroom attached, equipped with power machinery for grinding soils, fodders and the like.

The crops' laboratories include one for seed study, having a locker equipment for 50 students, and a laboratory for the study of cereals, forage crops, roots, etc., with lockers for 64 students. The equipment of these laboratories includes steam ovens, constant temperature electric ovens, ovens for seed germination, Brown-Duval moisture apparatus, balances, microscopes, and collections of seeds, grasses, tubers, weeds, etc. A balance room, root cellar and two storerooms, one of which is mouse-proof, are also used for crop work.

A modern steam-heated greenhouse 25 by 35 feet, used for work in soils and crops, is a valuable part of the equipment. Near the greenhouse is a crop garden on which different varieties of corn, grasses, clovers, etc., are grown for demonstration purposes, and as a source of material for class work. In addition, the general college farm of 250 acres is used for field study in soils and crops, and as a source of material.

Required Courses.

1. **I.** AGRONOMY. — Freshmen. Given as part of the freshman agriculture and horticulture. This course aims, by actual contact with the plants and the plant products, to make the students familiar with the common field, garden and orchard crops of Massachusetts.
Assistant Professor —— and the DEPARTMENT.

27. **III.** SOILS AND FERTILIZERS. — Sophomores. A study of soils and their properties, soil management, methods of soil improvement and maintenance of fertility, including the use of farm manures, commercial fertilizers and soil amendments.
4 class hours. 1 2-hour laboratory period, credit, 5.
Professor BEAUMONT and the DEPARTMENT.
Prerequisites, Freshman-required Chemistry.

Elective Courses.

50. **I.** FIELD AND FORAGE CROPS. — For juniors; seniors may elect. History, classification and production of corn and of those grasses, legumes, root and tuber crops suited to New England conditions. Crops of less importance in New England are briefly considered. The work includes lecture, laboratory and field study.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Assistant Professor —— and the DEPARTMENT.
Prerequisites, Agronomy 27, Botany 3.

51. **III.** ADVANCED FIELD CROPS. — For juniors; seniors may elect. Study of the cereals and other field crops not taken up or only briefly considered in Course 50. General problems of crop production are also considered, and the work is not entirely confined to New England conditions. The laboratory work includes a study of the cereals, the quality of seeds, grains and crop products, crop problems and field work with such crops as are available.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor —— and the DEPARTMENT.
Prerequisite, Agronomy 50.

75. **I.** ADVANCED SOILS. — For seniors; juniors may elect. A field, lecture and laboratory course on soils and their adaptability to different uses. The field work consists of a detailed study of soil textures, natural and spontaneous vegetation and other factors which indicate the fertility and adaptation of the soil; accompanied by a laboratory study of the physical properties of the soils sampled.
2 class hours. 1 4-hour and 1 2-hour laboratory period, credit, 5.
Professor BEAUMONT and Mr. THELIN.
Prerequisite, Agronomy 27. Advised, Geology, 27.

77. **II.** Manures and Fertilizers. — Seniors. An advanced course, giving a general discussion of the different theories which have been held relative to the functions and importance of manures and fertilizers, and leading up to the views at present accepted. Considerable attention is devoted to consideration of the experimental work which has been done, and which is now in progress. The laboratory work consists of a study of fertilizers, fertilizer mixtures, limes and culture work.

3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Beaumont and Mr. Thelin.
Prerequisite, Agronomy 27. Advised, Chemistry 27.

78. **II.** Breeding of Field Crops. — Seniors. This course deals with the improvement, by selection and breeding, of the crops studied in Courses 50 and 51.

2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor ——.
Prerequisite, Agronomy 51.

Animal Husbandry.

Professor Salisbury, Assistant Professor Rice, Mr. Thayer.

It is the purpose of this department to give students a broad, comprehensive knowledge of the subject of animal husbandry. The courses are arranged so that a student first studies the breeds of live stock and types and market classes of live stock. These courses are followed with courses in judging, breeding, feeding and management, so that the student has an opportunity to secure a thorough training in animal husbandry.

The department is equipped with an excellent laboratory, Grinnell Arena, which has a seating capacity of 180, and which is fully adapted to the requirements. There are upwards of 125 head of dairy cattle of various ages available for classroom work; among these are included superior representatives of the Jersey, Guernsey, Ayrshire and Holstein, of the best breeding and individuality. Considerable numbers of pure-bred Berkshire and Chester White pigs are maintained. The college possesses pure-bred Percherons besides several work teams of different types, which are available for classroom purposes. A set of plaster of Paris models of individuals of foreign and domestic breeds of horses, cattle, sheep and swine, and a collection of the different foodstuffs available for the use of the New England farmer, are included in the equipment for this work. An excellent set of upward of 250 lantern slides portraying the leading prize-winning, producing and breeding animals of the leading breeds, — horses, cattle, sheep and swine, — belongs to this department, and is regularly used in instructional work. This equipment is being added to from time to time as funds are available.

Required Course.

1. **II.** Animal Husbandry. — Freshmen. Given as part of the freshman agriculture and horticulture. This course acquaints the student with the foundations of the live-stock industry. In the lectures the types and

market classes of farm animals, and their uses, are considered; in the laboratory period elementary judging practice familiarizes the student with animals of the various types.

1 class hour. 1 2-hour laboratory period, credit, 2.

Mr. Thayer.

Elective Courses.

25. **I.** Types and Breeds of Live Stock. — Sophomores. A course covering the origin, history, development and characteristics of the different breeds of horses, cattle, sheep and swine. Textbook, Plumb's "Breeds and Types of Farm Animals."

2 lectures. 1 2-hour laboratory period, credit, 3.

Professor Salisbury and Mr. Thayer.

26. **II.** Types and Breeds of Live Stock. — Sophomores. Continuation of Course 25.

2 lectures. 1 2-hour laboratory period, credit, 3.

Professor Salisbury and Mr. Thayer.

Prerequisite, Animal Husbandry 25.

50. **I.** Feeding and Management. — For juniors. A study of the principles of animal nutrition; of the composition and qualities of feeding materials. Textbook, Henry's "Feeds and Feeding."

3 class hours. Credit, 3.

Assistant Professor Rice.

Prerequisite, Chemistry 30 or 51.

51. **II.** Feeds and Feeding. — For juniors. A study of feeding practice as related to all farm animals. Considerable work will be given in the formulating of rations.

3 class hours. Credit, 3.

Assistant Professor Rice.

Prerequisite, Animal Husbandry 50.

52. **III.** Advanced Stock Judging. — For juniors; seniors may elect. This course is designed to equip animal husbandry students in the judging of classes of different types of live stock; to strengthen them in the selection of superior sires; and equip them for stock judging at fairs. Visits will be made to the best herds for the various breeds of stock in the State. Judging teams to represent the college will be selected from this class.

1 2-hour and 1 4-hour laboratory period, credit, 3.

Professor Salisbury.

Prerequisite, Animal-Husbandry 25 and 26.

53. **III.** Principles of Breeding. — For juniors; seniors may elect. This course is designed to familiarize the student with the problems that are involved in animal improvement; to acquaint him with the facts which are already established; to scrutinize prevailing theories; and to indicate the lines and methods of further work. Some of the subjects studied are: variations,

their causes and heritability; DeVrie's theory of mutations; the inheritance of acquired characters; the pure line; Mendelian law; the making of new types; the determination of sex; applications to human heredity. A few periods at the end of the course are devoted especially to the application of principles in live-stock improvement. Supplementary reading.
3 class hours. Credit, 3.
Assistant Professor RICE.

Prerequisite, Zoölogy 25.

75. **I.** LIVE-STOCK MANAGEMENT. — For seniors. The work of this course consists of laboratory work by the individual students in the handling of live stock; with horses, such work as halter breaking, harnessing, casting and fitting for show will be done; similarly, the practical handling of cattle, sheep and swine will be fully treated. Special study is given to halter making, splicing, hitches, knots and all rope work.
2 lectures. 1 2-hour laboratory period, credit, 3.
Professor SALISBURY.

Prerequisites, Animal Husbandry 50 and 51.

78. **II.** HERD AND STUD-BOOK STUDY. — For seniors; juniors may elect. An advanced course in the study of the breeds of live stock, familiarizing the student with the detailed history of the breed, the most productive sires and dams of the various breeds, and the successful lines and methods of breeding.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor SALISBURY.

Prerequisite, Animal Husbandry 53.

80. **III.** SEMINAR. — For seniors majoring in animal husbandry only. Advanced study upon questions pertaining to live stock and live-stock production. Each student electing this work will choose some particular line of work in which he is specially interested, and will pursue study in this subject by reading, compilation and research. There will be no regular lecture period, but seminars will be held. A satisfactory report of the results must be presented in a thesis.
1 2-hour laboratory period, credit, 1.
Professors SALISBURY and RICE.

Dairying.

Professor LOCKWOOD, Professor JUDKINS, Assistant Professor YAXIS, Mr. UPTON.

The dairy manufactures building is new, well lighted and of sanitary construction. It is designed and equipped especially for teaching dairy manufactures. The equipment includes all kinds of machinery that are considered essential to the proper handling of milk and the making of cream, butter, ice cream and soft cheeses.

Course 77 is given for students who wish to get a general idea of dairy work and manufacturing processes. Part of the courses are arranged to give instruction in general dairy work as associated with Massachusetts agriculture; part are arranged to give to a smaller group of students more complete work in manufactures.

Elective Courses.

50. **I.** Milk and Milk Composition. — For juniors; seniors may elect. The development of the dairy business in the United States; the composition, secretion and general characteristics of milk; contamination and fermentation; the study of analysis of milk products by use of the Babcock test for fat, tests for acidity and adulteration, and ordinary preservatives; moisture tests for butter; methods for testing herds and developing them to higher efficiency; problems.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professors Judkins and Yaxis.

51. **III.** Butter Making. — For juniors; seniors may elect. A study of separators and cream separation; handling milk and cream for butter making; preparation of starters, and ripening cream; churning; markets and their requirements; marketing, scoring and judging butter; management; problems; dairy machinery and care thereof.
2 class hours. 2 3-hour laboratory periods, credit, 5.
Professor Judkins.

Prerequisite, Dairying 50.

75. **II.** Market Milk. — For seniors; juniors may elect. A study of market-milk conditions; extent and development of the business; supply and delivery; food value of milk and its uses as food; milk and its relation to the public health; proper methods for handling milk and cream for direct consumption; certified milk, requirements and production; pasteurizing; sterilizing; standardizing and modifying; milk laws and inspection.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Judkins.

Prerequisite, Dairying 50.

76. **III.** Milk Products. — For seniors; juniors may elect. The manufacture of milk products other than butter, including cheddar cheese, soft and fancy cheese, ice cream, condensed milk, casein, milk powder, etc. Laboratories, largely the making of soft and fancy cheese and ice cream.
2 class hours. 2 3-hour laboratory periods, credit, 5.
Mr. Upton.

Prerequisite, Dairying 75.

77. **I.** Dairying. — For seniors; juniors may elect. A general course designed primarily for students who wish to take only one course in dairying. The work given will cover briefly the composition and secretion of milk, the Babcock fat test, the relation of bacteria to dairy work and principles of creaming; separators; elementary butter making; proper methods of handling milk and cream; and the relation of market milk to the public health.
3 lecture hours. 2 2-hour laboratory periods, credit, 5.
Professor Judkins.

Farm Management.

Professor FOORD, Assistant Professor ABELL.

The purpose of the courses in this department is to introduce the student to a consideration of farming as a business. This involves a knowledge of the cost of production and the profit from the different enterprises such as dairy, poultry or orchard, and a study of the enterprises, and the relative amounts of each that will give the best use of labor and equipment on the farm under consideration.

The college farm of 250 acres is under the general supervision of the Department of Farm Management, and furnishes demonstration material. It includes improved land, pasture land and a farm wood lot. The improved land illustrates the value of good culture and the best known methods for the maintenance of fertility. The farm is equipped with suitable buildings and good machinery for the work carried on, of which the production of certified milk is an important branch. Several good farms in the vicinity, illustrating types of both special and general agriculture, may be inspected and studied. The offices of the department are in Stockbridge Hall.

75. **I.** FARM ACCOUNTS AND COST ACCOUNTING. — For seniors; juniors may elect. A study of farm inventories, single-enterprise accounts, complete farm accounts and farm records. Special emphasis is given to the interpretation of results and their application in the organization and management of the farm.

1 class hour. 2 2-hour laboratory periods, credit, 3.

Professors FOORD and ABELL.

76. **I.** FARM MANAGEMENT. — For seniors; juniors may elect. A study of farming as a business; regions and types of farming; the general principles of farm management and the influence of size, production, live stock and crop farming on the farmer's labor income; arrangement of fields and buildings; use of land, capital and labor; choosing and buying a farm.

2 class hours. 1 2-hour laboratory period, credit, 3.

Assistant Professor ABELL.

Prerequisites, Agronomy 50, Animal Husbandry 25 and 26, and some farm experience.

77. **III.** FARM MANAGEMENT. — For seniors; juniors may elect. A further and more specific study of the principles and practices as outlined in Course 76, with reference to their application to different regions of the United States and especially to New England. Trips to successful farms will be a required part of the course.

1 class hour. 2 2-hour laboratory periods, credit, 3.

Professors FOORD and ABELL.

Prerequisites, Farm Management 75 and 76.

78. **II.** SEMINAR. — For seniors majoring in general agriculture; others by arrangement.

1 class hour. Credit, 3.

The DEPARTMENT.

79. **III.** Seminar. — For seniors majoring in general agriculture; others by arrangement.
1 class hour. Credit, 3.
The Department.

Poultry Husbandry.

Professor Graham, Professor Payne, Dr. Goodale, Assistant Professor Banta, Mr. Ryan.

The introductory courses (1, 50, 51, 52, 53, 54) give a knowledge of the general routine of elementary poultry keeping. The advanced studies prepare men for the successful operation of poultry plants, either as owners or managers. In the graduate work further preparation may be secured for teaching, extension or investigation.

The poultry plant consists of 8 acres of land sloping gently to the west The buildings consist of three incubator cellars equipped with a number of lamp incubators and two mammoth machines with a total capacity of 9,000 eggs; a pipe brooder house (open pipe system) and 40 colony brooder houses which give a brooding capacity for 7,000 chicks, the equipment for these houses including a large variety of coal-stove brooders and kerosene hovers; a long laying house 14 by 180 feet, which accommodates 500 layers, furnishing facilities for student work in pen management, utility and fancy judging, etc.; and a laboratory 14 by 80, for killing, picking, drawing, trussing, packing, crate fattening and cramming. The fattening equipment consists of a modern sanitary all-steel battery with 16 compartments and 10 wooden crates, accommodating, altogether, 350 birds. There are also a storage building, 28 by 64 feet, for root cellar, poultry carpentry, poultry mechanics, feed room and storage; an experimental breeding house, 18 by 60; a combination laying, testing and breeding house, 18 by 72, for experimental purposes; a model laying house, 18 by 30, for 100 hens, and a house 20 by 40, for 200 hens. The six old experiment-station houses, each 12 by 18 feet, are used as special mating and overflow pens. The total capacity for laying hens is 1,600. A manure shed 14 by 18 feet; an oil and tool house 10 by 12; an incinerator 10 by 10; and two backyard model poultry houses 8 by 10 and 8 by 8 give a total of 76 buildings, not including a pheasant run, 16 roosting sheds 10 by 10, and numerous small coops for natural incubation and brooding.

Required Course.

1. **I.** Poultry Husbandry. — Given as part of the freshman agriculture and horticulture. The object of this course is to familiarize the student in a general way with the fundamental principles of poultry husbandry, — breeds and varieties of poultry, types of houses, feeds and feeding, management, marketing and the principles of incubation and brooding.
1 2-hour period, credit 1.
Assistant Professor Banta.

Elective Courses.

50. **I.** Elements of Poultry Culture. — For juniors; seniors may elect. This course consists of a comprehensive study of opportunities in poultry culture, poultry-house construction, poultry-house equipment, feeds and feeding, winter-egg production, types and breeds of poultry.
3 class hours. Credit, 3.
Professor Graham, Professor Payne and Assistant Professor Banta.

51. **I.** Poultry Practice Work. — For juniors; seniors may elect. This is a practical laboratory course providing a study of external parasites, insecticides, poultry carpentry, caponizing, killing and picking; dressing and packing poultry.

2 2-hour laboratory periods, credit, 2.
Professor Payne.

Prerequisite, must be accompanied by Poultry 50.

52. **II.** Elements of Poultry Culture. — For juniors; seniors may elect. This course treats the subjects of incubation, brooding, care of growing stock, breeding for egg-production and diseases of poultry.

3 class hours. Credit, 3.
Professor Payne and Assistant Professor Banta.

Prerequisite, Poultry 50.

53. **III.** Incubation and Brooding. — For juniors; seniors may elect. In this course students are required to set up and operate incubators and brooders, make a systematic study of the development of the chick in the egg and the care of sitting hens. Laboratory time by arrangement.

1 class hour. 4 2-hour laboratory periods, credit, 5.
Professor Payne.

Prerequisite, Poultry 52.

54. **III.** Pen Management. — For juniors; seniors may elect. This is a practical laboratory course. Students are required to care for a pen of fowls, keeping accurate records of eggs produced, food consumed, weather conditions, health of fowls and profit and loss.

1 2-hour laboratory period, credit, 1.
Assistant Professor Banta.

Prerequisite, Poultry 50.

55. **I, II** and **III.** Investigational Work. — Seniors. This course is designed especially for students who are planning to do experiment station work. Students will be assigned specific problems to work out experimentally, or they may be required to assist in carrying on such work.

1 to 5 2-hour laboratory periods, credits, 1 to 5.
Dr. Goodale.

75. **II.** Poultry Management. — Seniors. A detailed study of large poultry farms and their equipment, such as bone cutters, feed cutters, cramming machines, etc.; the laying out and planning of poultry buildings of all kinds; mating of fowls. Attention to poultry diseases and investigation work carried on by experiment station is prominent. A few good poultry plants will be visited by the class for practical demonstrations.

5 class hours. Credit, 5.
Professor Graham.

Prerequisites, Poultry 53, 54, 76 and 77.

76. **I.** ADVANCED POULTRY JUDGING. — Seniors. This course includes a study of the origin and history of breeds and varieties, poultry organizations and poultry shows. The laboratory work covers score card and comparative judging of exhibition and utility poultry; conditioning show birds, and applying the latest methods of selecting high and low producing hens. A few of the best Connecticut Valley poultry shows will be visited by the class. The American Standard of Perfection will be used as a text.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Assistant Professor BANTA.
Prerequisite, Poultry 53.

77. **I.** MARKET POULTRY AND POULTRY PRODUCTS. — Seniors. This course includes the study of market classifications of poultry, eggs and feathers, the requirements of different markets, methods of marketing, advantages and disadvantages of cold storage of poultry and eggs. Students will be required to fatten several lots of chickens by different methods and rations. Accurate data must be kept showing the gain in weight and quality, also the cost of feed, labor, etc., and the profit and loss. Preserving eggs, judging and scoring of market poultry, both alive and dressed, and market eggs will be an important feature of this course.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor PAYNE.
Prerequisites, Poultry 50, 51 and 52.

78. **III.** FARM POULTRY. — Seniors; juniors may elect. This course is offered for those students who desire a general knowledge of poultry husbandry, but who cannot devote more than one term to the subject. It is not intended for students specializing in poultry, and such students are admitted only by special permission. Emphasis will be placed on the farm flock and its economic management. Utility classification, housing, culling, feeding, hatching, rearing, production, marketing and disease control will receive special consideration.
3 class hours. 2 2-hour laboratory periods, credit, 5.
The DEPARTMENT.

Rural Engineering.

Professor GUNNESS, Assistant Professor STRAHAN, Mr. PUSHEE, Mr. NEWLON.

The courses in rural engineering are planned to give a working knowledge of those phases of engineering which apply directly to the farm. It is expected that the student will get a clear understanding of modern farm practice as it relates to permanent improvements of the farm and the farmstead, and in the selection and use of farm equipment.

This department has an office and the use of a lecture room in Stockbridge Hall. The work on farm structures is given in the large drawing room in the same building. This room is fitted with thirty drawing tables. Models and blue prints are available for the study of farm buildings. A set of post molds and a machine for making cement tile afford opportunity for practical work with cement.

The rural engineering shop building is a one-story structure 68 by 126 feet. The carpenter shop in this building is fitted with benches fully equipped with tools for each student. A saw table is available for getting out material. The general repair shop is equipped with forges, benches, a drill press and grinders. The laboratory for farm machinery and farm motors is equipped with a complete line of field machines, gasoline engines, tractors and pumps. A complete assortment of engine accessories, consisting of carburetors, magnetos, etc., is available for thorough instruction in gas engines. A small dynamo and switchboard are used in the study of farm-lighting systems. The work on the small field machines is given in the basement of Stockbridge Hall, and the work on steam engines and steam heating is given in Flint Laboratory.

Elective Courses.

25. **I** and **III.** CARPENTRY. — For sophomores; juniors and seniors may elect. Practice in the use of tools by exercises in bench work, repair of farm equipment and farm building construction.

2 2-hour laboratory periods, credit, 2.
Mr. PUSHEE.

26. **II** and **III.** REPAIR OF FARM EQUIPMENT. — For sophomores; juniors and seniors may elect. Exercises in forge work, pipe fitting, soldering, babbitting and fitting bearings, lining up shafting, lacing belts and splicing rope. Practice in the use of machinist's tools, such as file, cold chisel, drill press, taps and dies.

2 2-hour laboratory periods, credit, 2.
Mr. NEWLON.

75. **I.** For seniors; juniors may elect. Study of the strength and durability of building materials; water supply; lighting and heating systems for the farm; lightning protection; drawing plans, writing specifications and estimating the cost of buildings; concrete construction as applied to foundations, silos, tanks, posts, floors and walks.

3 class hours. 2 2-hour laboratory periods, credit, 5.
Assistant Professor STRAHAN.

77. **II.** POWER MACHINERY. — For seniors; juniors may elect. Steam and gasoline engines, refrigerating machinery, electric motors and dynamos. Practice in pipe fitting, soldering, babbitting and fitting bearings, lacing belts and packing valves. Course 77 is intended primarily for dairy students, but would be valuable to any man who would expect to use engines, pumps or electrical machinery.

2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor GUNNESS.

78. **III.** FARM MACHINERY. — For seniors; juniors may elect. Study of the care and operation of tillage, seeding, harvesting, pumping and spraying machinery; steam and gas engines and gas tractors. Special attention will be given to the use of power on the small farm.

2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor GUNNESS.

79. **III.** Drainage and Irrigation Engineering. — For seniors; juniors may elect. This course covers the engineering phase of drainage and irrigation. The various systems are studied, and practice is given in the design of drainage and irrigation systems. Field work gives practice in surveying for drains, platting, locating drains, erecting batterboards and laying tile. Practice is given in assembling equipment for spray irrigation, and the flow of water through nozzles is studied by means of laboratory tests.

2 class hours. 3 2-hour laboratory periods, credit, 5.

Assistant Professor Strahan.

DIVISION OF HORTICULTURE.

Professor Waugh.

[Heavy-faced Roman numerals indicate the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Floriculture.

Professor Thayer.

The courses in floriculture are intended to give the student a general knowledge of all phases of greenhouse design, construction, heating and management, the culture of florists' crops (under glass and in the field), floral decoration and arrangement. The department aims to train students so that they may take up commercial floriculture (either in the growing or retail business) and the management of conservatories on private estates, in parks and cemeteries.

The department is especially well epuipped for the teaching work, probably being surpassed in no other agricultural college. French Hall, with its laboratories, classrooms and offices, furnishes excellent facilities for the purposes of instruction. The glass area of the department consists of approximately 20,000 square feet, divided as follows: French Hall range of 7,200 square feet, a durable, practical, commercial range composed of palm and fern, violet, carnation, rose and students' houses; the old Durfee range of 7,400 square feet, devoted to the growing of decorative, conservatory and bedding plants and chrysanthemums; one house of 3,200 square feet, suitable for propagating work and general plant culture; and approximately 2,200 square feet in cold frames and hotbeds.

In addition, the department has 2 acres of land used for the summer culture of carnations, violets, gladioli, dahlias, sweet peas, bedding plants, etc. This also includes a small garden of about 4,700 square feet devoted to the culture of annuals. A large collection of biennials and herbaceous perennials is maintained and is being enlarged from year to year; at the present time the collection consists of several hundred species and varieties, and provides an excellent opportunity for the study of garden flowers.

Elective Courses.

50. **I.** Greenhouse Management. — For juniors; seniors may elect. This course is designed to familiarize students with the methods followed in the management of greenhouse crops. The students are instructed in the practical operations of watering, potting, fumigating, ventilating and in the methods of propagation of plants. In addition the use of cut flowers and plants in decorative work, arrangement of flowers in baskets, designs, vases, table and home decorations will be considered. Students will be expected to arrange their hours according to the needs of the work.

2 class hours. 1 4-hour laboratory period, credit, 4.

Professor Thayer.

Prerequisite, Horticulture 27.

51. **II.** Greenhouse Management. — For juniors; seniors may elect. Continuation of Course 50.
2 class hours. 1 4-hour laboratory period, credit, 4.
Professor Thayer.
Prerequisite, Floriculture 50.

52. **III.** Greenhouse Management. — For juniors; seniors may elect. A continuation of Courses 50 and 51.
2 class hours. 1 4-hour laboratory period, credit, 4.
Professor Thayer.
Prerequisite, Floriculture 51.

53. **I.** Greenhouse Construction. — For juniors; seniors may elect. The location, arrangement, construction, cost, heating and ventilating of greenhouse structures; also the drawing of plans and drafting of specifications for commercial houses and private ranges. Such practical work as glazing, the construction of concrete benches and cold frames will be included in this course.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Thayer.
Prerequisite, should be taken with Floriculture 50.

54. **II.** Greenhouse Construction. — For juniors; seniors may elect. A continuation of Course 53.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Thayer.
Prerequisite, Floriculture 53.

75. **I.** Commercial Floriculture. — Seniors. A detailed study will be made of the methods of culture for greenhouse plants and cut flowers for wholesale and retail markets. The care and marketing of all florists' crops will also be considered. Assigned readings on these topics.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Thayer.
Prerequisite, Floriculture 52.

76. **II.** Commercial Floriculture. — Seniors. As stated under Course 75.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Thayer.
Prerequisite, Floriculture 75.

79. **III.** Commercial Floriculture. — Seniors. As stated under Course 75.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Thayer.
Prerequisites, Floriculture 76.

77. **II.** Conservatory Work and Decorative Plants. — Seniors. A study of the tropical and subtropical foliage and flowering plants used in conservatory work. Their arrangement and care will also be considered. Assigned readings.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Thayer.

Prerequisite, Floriculture 75.

78. **III.** Garden Flowers and Bedding Plants. — Juniors and seniors. This course aims to make the student familiar with those annuals, herbaceous perennials, bulbs and bedding plants used in landscape work. Their propagation, culture and uses will be considered. Assigned readings and field trips.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Thayer.

80. **III.** Seminar. — For seniors majoring in floriculture only. Advanced study of subjects pertaining to commercial floriculture or private garden work. All students electing this work will be assigned a specific problem, and will pursue study in these problems by reading and research. No regular lectures will be given, but seminars will be conducted each week. A satisfactory report of the results must be presented.
2 to 6 laboratory hours. Not to exceed 3 credits.
Professor Thayer.

Forestry.

Professor Grose.

The forestry major is designed to give the student a grounding in the branches of natural science upon which forest development is based. It continues, further, to give him a knowledge of such practical forestry details as the distinguishing characteristics of the various species of trees and commercial lumber, the principles of silviculture, forest management, forest utilization, and forest nursery practice.

The department has an unusually complete equipment of the various instruments used in forest mensuration, forest mapping and engineering, timber estimating, log scaling, board measuring, etc.; and a large assortment of boards illustrative of the various commercial woods found in the lumber markets. The State Forest Nursery, comprising 6 acres of land and containing, approximately, 5,000,000 trees, transplants and seedlings, is on the college farm. Extensive forests containing every variety of tree common to New England are within walking distance of the college. The college campus affords an arboretum containing an exceptionally large number of trees not native to New England. The Mount Toby Demonstration Forest has an area of approximately 750 acres, and contains the various types of forest growth found throughout the State. It serves as a field laboratory in which students have the privilege of working out problems in silviculture, forest mensuration and management. Improvement cuttings, cuttings for utilization, and forest plantings are conducted by the forestry department, and every opportunity is offered the student to familiarize himself with the practical side of forest work.

Elective Courses.

50. **I.** Dendrology. — For juniors; seniors may elect. During the first part of the term frequent field trips will be made to identify and study the habits of our native forest trees. Later, the classification, range, distribution, forest habits, quality, uses and identification of wood of the commercial timber trees of the United States will be studied. Lectures, recitations, laboratories or field work at option of instructor.

3 2-hour laboratory periods, credit, 3.
Professor Grose.

51. **II.** Wood Technology. — For juniors; seniors may elect. A study of the commercial woods found in the lumber markets, methods of identification, uses, strength values, technical qualities, decay and methods of preservation.

1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Grose.

52. **III.** Principles of Forestry. — For juniors; seniors may elect. A lecture course for the purpose of giving the students a general view of the whole field of forestry and what forestry attempts to accomplish and has accomplished. Not required of students who propose to major in forestry.

2 class hours. Credit, 2.
Professor Grose.

53. **III.** Silviculture. — For juniors; seniors may elect. Factors influencing forest growth; forest types; silvicultural systems; care and protection of forests; forest description; forest nursery practice and forest planting.

1 class hour. 1 4-hour laboratory period, credit, 3.
Professor Grose.

Prerequisite, Forestry 50.

54. **IV.** Arboriculture. — For juniors; seniors may elect. A course dealing with problems of shade tree propagation, protection and repair; the choice and grouping of species; shade tree laws. Assigned readings.

120 hours' field work, credit, 5.
Professor Grose.

75. **I.** Forest Mensuration. — For seniors; juniors may elect. Methods of determining the volume of trees, logs and entire forests. Methods of computing volume tables, tree and forest growth and yield tables. Timber estimating.

3 class hours. 72 hours' field work, credit, 5.
Professor Grose.

78. **III.** Seminar — Report. — Seniors. This may involve research, laboratory or field work in the investigation of some subject, together with a review of the literature relating to it and an original written report evidencing the results. Subject to be chosen in conference with Professor Clark.

6 laboratory hours, credit, 3.
Professor Grose.

Horticultural Manufactures.

Professor Chenoweth, Mr. Robertson.

The courses offered aim to give the student a practical knowledge of the problems connected with food preservation. Emphasis is placed upon the conservation of the cheaper grades of fruits and vegetables, to the end that the whole crop may be marketed at a profit and that good wholesome food products may result from what would otherwise be lost.

The social and economic values of this line of work are constantly emphasized with the intent of broadening and liberalizing the students' view of these problems.

The department occupies three laboratory rooms in Flint Laboratory, two in Fisher Laboratory, with offices in Wilder Hall and French Hall. The laboratories are fitted with desks for 18 students. The desk equipment contains the necessary utensils for doing general laboratory work in food preservation. The general equipment of the department, both for the use of students and for manufacturing purposes, may be grouped under the following heads: —

1. *Canning.* — A modern canning outfit, including both steam-pressure cookers and hot-water baths, hand and power can sealers, peeling and slicing machines, a string-bean cutter, heat-penetration thermometers, electric incubator and a large assortment of all types of home canning equipment.

2. *Evaporation.* — Two small orchard evaporators, a tunnel drier, peeling machines, slicers and a general assortment of driers adapted to home evaporation.

3. *Fruit Juices, Butters, etc.* — A hand cider mill, a motor-driven hydraulic press, a steam-jacketed kettle, an apple-butter cooker, and cider and vinegar testing apparatus.

Elective Courses.

75. **I.** Horticultural Manufactures. — For seniors and graduate students. A practical course in food preservation dealing primarily with fruits and vegetables. The canning of fruits and vegetables as practiced in the home and in commercial canneries; evaporation of fruits and vegetables, the various types of equipment and methods of preparation of products. The manufacture of (*a*) fruit products, such as butters, jams, jellies, fruit juices, marmalades, preserves, vinegars, pastes, etc.; (*b*) vegetable products, as pickles, piccalilli, sauerkraut, soups, etc. Particular attention will be given to study and use of all types of equipment suitable for use in the home or small factory, together with methods for testing a large variety of manufactured products. During this term the emphasis will be on canning, drying and study of equipment.

2 class hours. 3 2-hour laboratory periods per week, credit, 5.

Professor Chenoweth.

76. **II.** Horticultural Manufactures. — For seniors and graduate students. A continuation of Course 75. The emphasis in this course is placed on the manufacturing and testing of fruit and vegetable products.

1 class hour. 2 laboratory periods per week, credit, 3.

Professor Chenoweth.

Prerequisite, Horticultural Manufactures 75.

Horticulture.

Professor Waugh, Assistant Professor Thompson.

The general subject of horticulture divides naturally into subjects of pomology, floriculture, forestry, landscape gardening and market gardening. A number of courses relate to more than one of these subjects, and are therefore grouped here under the general designation of horticulture.

Required Course.

1. **I.** Horticulture. — Freshmen. Given as part of the freshman agriculture and horticulture.

Elective Courses (General).

27. **III.** Nursery Practice. — For sophomores; juniors and seniors may elect. This course treats of the fundamental methods of plant propagations by seeds, cuttings, budding, grafting, etc. Lectures and practicums.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Thompson.

50. **I.** Plant Materials. — For juniors; seniors may elect. This course aims to make the student familiar with the character of the trees, shrubs and herbaceous perennials used in ornamental work, and with the methods of propagating them.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Assistant Professor Thompson.
Prerequisite, Horticulture 27.

51. **III.** Plant Materials. — For juniors; seniors may elect. A continuation of Course 50, taking up the field use of trees, shrubs and herbaceous plants, their native habitats, soils and plant associations, with a view to supplying to students in landscape gardening and floriculture a knowledge of plant species. Frequent practicums and field excursions.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Assistant Professor Thompson.
Prerequisite, Horticulture 50.

Landscape Gardening.

Professor Waugh, Assistant Professor Harrison.

The purposes of the courses in landscape gardening are: (1) to train men for the profession in all its branches. As a rule graduates should first enter the employ of established landscape architects, nurserymen or park superintendents, and after an apprenticeship of several years those who have the requisite technical and business ability may set up for themselves. (2) To train men for public-service work in national, State and municipal parks and forests. (3) To train men for country planning, this function being exercised through various public institutions and organizations. (4) To train teachers and extension workers in lines of landscape gardening and civic improvement. (5) To give a broad and liberal general education stressing the fundamental principles of art.

The department has large, well-lighted drafting rooms, with all necessary equipment, such as planimeters, eidograph, pantograph, blue-printing outfit, etc.; and a complete outfit of surveying instruments, including transits, levels, plane tables, prismatic compasses, hand levels, etc. The college campus presents an unusually good collection of the plant materials used in landscape gardening.

Elective Courses.

50. **I.** MAPPING AND TOPOGRAPHY. — Juniors. Reconnoissance surveys and mapping, with special reference to the methods used in landscape gardening; detailed study of selected designs of leading landscape gardeners; grade design, road design and field work. Must be followed by Course 51.

2 2-hour laboratory periods; 2 3-hour laboratory periods, credit, 5.
Assistant Professor HARRISON.

Prerequisites, Mathematics 26 and 27, Drawing 25, 26 and 27, Horticulture 27.

51. **II.** ELEMENTS OF LANDSCAPE GARDENING. — Juniors. As stated under Course 50.

3 3-hour laboratory periods, credit, 4.
Assistant Professor HARRISON.

Prerequisite, Landscape Gardening 50.

52. **III.** GENERAL DESIGN. — Juniors. Field notes; examination of completed works and those under construction; design of architectural details, planting plans, gardens, parks and private grounds; written reports on individual problems. Must be followed by Course 53.

2 2-hour laboratory periods; 2 3-hour laboratory periods, credit, 5.
Assistant Professor HARRISON.

Prerequisites, Landscape Gardening 50 and 51, and either plant materials (Horticulture 50 and 51) or advanced mathematics.

75. **I.** THEORY OF LANDSCAPE ART. — For seniors and graduates. The general theory and applications of landscape study, including a brief history of the art.

3 class hours. Credit, 3.
Professor WAUGH.

76. **II.** CIVIC ART. — Seniors. The principles and applications of modern civic art, including city planning, city improvement, village improvement and rural improvement, with special emphasis upon country planning. Must be followed by Course 77.

3 3-hour laboratory periods, credit, 4.
Professor WAUGH.

Prerequisite, Landscape Gardening 53.

77. **III.** COUNTRY PLANNING. — Seniors. As stated under Course 76.

3 3-hour laboratory periods, credit, 4.
Professor WAUGH.

Prerequisite, Landscape Gardening 76.

78. **III.** ARCHITECTURE. — Alternating with Course 79; given in 1918–19. Juniors and seniors. The history of architectural development, the different historic types, with special reference to the underlying principles of construction and design and their relations to landscape design. Illustrated lectures, conferences, practice in designing.
3 class hours. Credit, 3.
Assistant Professor HARRISON.

79. **III.** CONSTRUCTION AND MAINTENANCE. — Alternating with Course 78; given in 1919–20. Juniors and seniors. Detailed instruction in methods of construction and planting in carrying out plans, in organization, reporting, accounting, estimating, etc.; maintenance work in parks and on estates, its organization, management, cost, etc.
3 class hours. Credit, 3.
Assistant Professor HARRISON.

80. **I.** THEORY OF DESIGN. — Juniors. As stated under Course 52. [Will be given in the summer term when that is established; meantime, will be given in term **I**, senior year.]
120 laboratory hours, credit, 4.
Professor WAUGH.
Prerequisite, Landscape Gardening 52.

81. **II.** ESTATE DESIGN. Credit, 4.
Assistant Professor HARRISON.

82. **III.** PARK DESIGN. Credit, 4.
Assistant Professor HARRISON.

Pomology.

Professor SEARS, Assistant Professor DRAIN, Mr. GOULD.

The object of the courses in pomology is to give the student a training which shall be at once thoroughly practical and yet scientific. This will fit the men to enter the field of practical fruit-growing, or it will furnish an excellent foundation for further study in case the student elects to take up research or teaching work.

The department has 50 acres in fruit plantations. The apple orchards are the most extensive, comprising about 35 acres of various ages, but there are also blocks of pears, peaches, plums and cherries. In small fruits there are plantings of strawberries, raspberries, blackberries, currants and gooseberries. There are three vineyards, with a total area of 5 acres, in which the leading varieties and the principal types of pruning and training are represented. In these plantations are 50 varieties of grapes, representing three native American species and many hybrids; 20 varieties of peaches; 20 varieties of pears; 25 of plums, including five species and many hybrids; and 100 varieties of apples.

The department has an excellent equipment of spraying and dusting machinery, including various styles and sizes of power sprayers, and many types of barrel pumps and smaller sprayers. There is also an excellent assortment of orchard tools, including plows, harrows, fertilizer sowers, etc.

Fisher Laboratory is one of the best planned and equipped packing and storage plants to be found in the United States. It includes six refrigerated rooms of various sizes; four storage rooms not refrigerated; one large laboratory room and one classroom, besides ample storage room for fruit packages and equipment. The equipment for the building itself includes four types of apple sizers; packing tables and box and barrel presses of various types, besides all kinds of packages and the smaller equipment necessary for thoroughly modern work in grading and packing fruit. The department is well equipped with lockers and with pruning and other tools for the use of students in laboratory work. Such work is made a leading feature in all the courses in pomology.

Elective Courses.

50. **I.** PRACTICAL POMOLOGY. — For juniors; seniors may elect. A study of the general principles of the growing of fruits, dealing with such questions as selection of site, soils, windbreaks, laying out plantations, choice of nursery stock, pruning, culture of orchards, orchard fertilizers, cropping orchards, etc. Lectures, supplemented with text and reference books; field and laboratory exercises.

2 class hours. 1 2-hour laboratory period, credit, 3.
Professor SEARS.

Prerequisite, Horticulture 27.

51. **II.** PRACTICAL POMOLOGY. — For juniors; seniors may elect. As stated under Course 50.

2 class hours. 1 2-hour laboratory period, credit, 3.
Professor SEARS.

Prerequisite, Pomology 50.

52. **III.** PRACTICAL POMOLOGY. — For juniors; seniors may elect. As stated under Course 50.

2 class hours. 1 2-hour laboratory period, credit, 3.
Professor SEARS.

Prerequisite, Pomology 51.

53. **IV.** (Summer.) SMALL FRUITS. — For juniors; seniors may elect. The growing, harvesting, marketing and storing of small fruits, including raspberries, blackberries, strawberries, currants, gooseberries and grapes, together with thinning, spraying, picking and marketing of tree fruits at the college orchards and in private commercial orchards.

120 laboratory hours, credit, 5.
The DEPARTMENT.

75. **I.** SYSTEMATIC POMOLOGY. — Seniors. A study of the varieties of the different fruits and of nomenclature, with critical descriptions; special reference being given to relationships and classification. Lectures, laboratory and field exercises.

1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor DRAIN.

Prerequisite, Pomology 52.

76. **II.** Systematic Pomology. — Seniors. As stated under Course 75.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Drain.

Prerequisite, Pomology 75.

77. **I.** Commercial Pomology. — Seniors only, majoring in pomology. The picking, handling, storing and marketing of fruits, including a discussion of storage houses, fruit packages, methods of grading and packing. Especial emphasis is placed upon laboratory and field work, where the student is given actual practice in the picking and packing of all the principal fruits.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Mr. Gould.

Prerequisite, Pomology 52.

78. **III.** Spraying. — Seniors. A study of (*a*) spraying materials, their composition, manufacture and preparation for use; the desirable and objectionable qualities of each material, formulas used, cost, tests of purity. (*b*) Spraying machinery, including all the principal types of pumps, nozzles, hose and vehicles; their structure and care. (*c*) Orchard methods in the application of the various materials used, with the important considerations for spraying each fruit and for combating each orchard pest. This course is designed especially to familiarize the student with the practical details of actual spraying work in the orchard. Spray materials are prepared, spraying apparatus is examined and tested, old pumps are overhauled and repaired, and the actual spraying is done in the college orchards and small-fruit plantations.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Pomology 52.

79. **III.** General Pomology. — For seniors; juniors may elect. This course is planned to meet the needs of those students who cannot devote more than one term to the subject but who want a general knowledge of fruit growing. The work will consist of lectures and laboratory exercises on such topics as choosing the locations, kinds and varieties of fruits to grow, securing and setting the plants, care and cultivation, pruning, spraying, pests, harvesting and storing.
2 class hours. 1 2-hour laboratory period, credit, 3.
The Department.

80. **I.** Seminar. — For seniors majoring in pomology. Advanced study of problems relating to the business of fruit growing. Each student will be assigned a major and a minor problem in lines of work in which he is particularly interested. He will pursue his studies both by reading and research, and the materials obtained will be worked into theses which will be presented to the seminar for discussion. Reports on minor problems will be taken up first. No lectures will be given, but seminar meetings will be held for one period each week.

Credit, 1.
Professor Sears.

81. **II.** SEMINAR. — For seniors majoring in pomology. A continuation of Course 80. One seminar meeting each week.

Credit, 1.
Professor SEARS.

82. **III.** SEMINAR. — For seniors majoring in pomology. A continuation of Course 81. One seminar meeting each week.

Credit, 1.
Professor SEARS.

Vegetable Gardening.

Professor TOMPSON, Professor DACY, Mr. HARRIS.

Course 50 is offered for students who desire a general view of the subject, which may be secured in one term. The other courses cover very thoroughly the principles and practices of the commercial production of vegetables in the open, and the forcing of vegetables in cold frames, hotbeds and greenhouses. They are designed for students who wish to engage in the business for themselves or for others, or who wish to become teachers or investigators in the more technical phases of the subject.

The department has 12 acres of land, greenhouses, hotbeds and cold frames, with modern equipment devoted to the production of a wide variety of crops. These afford excellent subject-matter for study, and opportunity for close contact with the actual problems of the business.

Elective Courses.

50. **I.** GENERAL VEGETABLE GARDENING. — Juniors; seniors may elect. A general course for students not specializing in vegetable gardening. Designed to teach the fundamentals of vegetable gardening. Soils, fertilizers, garden crops, general methods of management. [Offered for first time in 1919-20.]

2 class hours. 1 2-hour laboratory period, credit, 3.
Professor DACY.

51. **I.** PRACTICAL VEGETABLE GARDENING. — Juniors; seniors may elect. A study of the principles of vegetable gardening. Deals with such questions as the selection of a location; soils, manures and fertilizers, green manure and cover crops; seeds and seeding; the construction and management of hotbeds and cold frames; garden planning, planting, tillage, irrigation; control of insects and diseases; harvesting, marketing and storing. Includes a detailed study of the cultural requirements of the common vegetable crops, and the principles of rotation and double cropping. Text and reference books. Laboratory and field exercises.

2 class hours. 1 2-hour laboratory period, credit, 3.
Professor DACY.

Prerequisite, Horticulture 27.

52. **II.** PRACTICAL VEGETABLE GARDENING. — Juniors; seniors may elect. As stated under Course 51.

2 class hours. 1 2-hour laboratory period, credit, 3.
Professor DACY.

Prerequisite, Vegetable Gardening 51.

53. **III.** Practical Vegetable Gardening. — Juniors; seniors may elect. As stated under Course 51.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Dacy.

Prerequisite, Vegetable Gardening 52.

54. **IV.** Vegetable Gardening Practice. — Field work in summer term after junior year. The work of this course will be under the direct supervision of an instructor, and will give the student an unusual opportunity to learn, at first hand, the methods and problems of commercial vegetable growing. Most of the work will be in the field devoted to seed planting, cultural practices, harvesting and preparing for market. Required of those majoring in vegetable gardening.
120 laboratory hours, credit, 5.

Prerequisite, Vegetable Gardening 53.

75. **I.** Systematic Vegetable Gardening. — Seniors. This course will include the systematic study of varieties, types and strains of the leading vegetable crops; the establishing of types, determination of quality of varieties; seed growing, variety improvement, rogueing, seed harvesting, curing and storing.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Dacy.

Prerequisite, Vegetable Gardening 54.

76. **II.** Greenhouse Construction and Vegetable Forcing. — Seniors. A study of types, materials, construction, location, arrangement, capacity and cost of greenhouses for growing vegetables. A brief consideration of the heating plant, — the type, installation, piping and management; also the study of greenhouse vegetable crops and their production as practiced by commercial growers.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Dacy.

Prerequisite, Vegetable Gardening 75.

77. **III.** Commercial Vegetable Growing. — Seniors. A consideration of vegetable growing as a business. A study of this specialized type of farming, including places where developed, types, extent, economic importance, capitalization, equipment and other fundamental problems of commercial vegetable gardening. Students will assist in the planning and operation of a typical market-gardening area. Visits will be made to market-gardening and truck-gardening farms.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Dacy.

Prerequisite, Vegetable Gardening 76.

78. **I.** SEMINAR. — For seniors majoring in vegetable gardening. Each student will be assigned problems relating to the business of vegetable gardening. Reports on the work on these problems will be made each week to the seminar, and the results presented as a thesis.

Credit, 1.
Professors TOMPSON and DACY.

79. **II.** SEMINAR. — For seniors majoring in vegetable gardening. A continuation of Course 78. One seminar meeting each week.

Credit, 1.
Professors TOMPSON and DACY.

80. **III.** SEMINAR. — For seniors majoring in vegetable gardening. A continuation of Course 79. One seminar meeting each week.

Credit, 1.
Professors TOMPSON and DACY.

Drawing.

Elective Courses.

25.[1] **I.** FREE-HAND DRAWING. — For sophomores; juniors and seniors may elect. Lettering; free-hand perspective; sketching from type models, leaves, flowers and trees, houses, etc.; laying flat and graded washes in water colors; water-color rendering of leaves, flowers and trees; conventional coloring and map rendering in water colors; conventional signs and mapping in ink.

3 2-hour laboratory periods, credit, 3.

26.[1] **II.** MECHANICAL DRAWING. — For sophomores; juniors and seniors may elect. Inking exercises; geometric problems; projection; intersections; isometric; shades and shadows; parallel; angular and oblique perspective; perspective drawing of buildings. Students should have preparation in plane and solid geometry.

3 2-hour laboratory periods, credit, 3.

27.[1] **III.** MECHANICAL DRAWING. — For sophomores; juniors and seniors may elect. As stated under Course 26.

3 2-hour laboratory periods, credit, 3.

Prerequisite, Drawing 26.

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[1] Given by Assistant Professor Harrison.

DIVISION OF SCIENCE.

Professor Fernald.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Botany.

Professor Osmun, Professor Anderson, Assistant Professor Clark, Assistant Professor McLaughlin, Dr. Torrey.

A knowledge of the principles of plant life is fundamental in agricultural education. The required courses in botany are planned with this and the general educational value of the subject in view. Elective courses are of two types: (1) those which have for their chief aim the direct support of technical courses in agriculture and horticulture, and (2) those providing broader, more intensive training in the science. Courses in the second group may lead, when followed by postgraduate study, to specialization in the field. They also furnish excellent training for those specializing in other sciences and in scientific agriculture. In all undergraduate courses the relation of the science of botany to agriculture is emphasized.

The department occupies Clark Hall, a brick building 55 by 95 feet, two stories high, with basement and attic. The building has two lecture rooms with seating capacity of 154 and 72, respectively; one seminar and herbarium room; large laboratories for general and special work; and smaller rooms for advanced students. A glass-enclosed laboratory for plant physiology adjoins the main building and provides unusual facilities for the study of phenomena of plant life. In addition, a greenhouse 28 by 70 feet is connected with the building. This is for experimental work in plant pathology and physiology, and for growing plants needed for instruction. The experiment station laboratories devoted to botanical research are in this building.

The laboratories and lecture rooms are of modern construction, finely lighted, and equipped with compound and dissecting microscopes, microtomes, paraffin and drying ovens, physiological and other apparatus, and a large collection of charts. The herbarium contains about 20,000 sheets of seed plants and ferns, 1,200 sheets of liverworts and mosses, and 25,000 specimens of fungi. Facilities and equipment for the study of plant physiology and pathology are excelled in few other institutions.

Required Courses.

3. **III.** Introductory Botany. — Freshmen. This course presents the seed plants as plastic organisms molded by their environment. It also introduces the student to methods of identifying and classifying plants.

An herbarium, illustrative of systematic, ecological and economic features, is started in the spring, but need not be presented until fall when credit is given in Course 25. This makes it possible for the interested student to familiarize himself with the flora of the full growing season.

1 class hour. 2 2-hour laboratory periods, credit, 3.

Dr. Torrey and Assistant Professor McLaughlin.

25. **I.** INTRODUCTORY BOTANY. — Sophomores. The anatomy and physiology of the seed plants (Phanerogamia), with a brief summary of the lower forms of plant life. The herbarium started in connection with Botany 3 is presented as part of this course.

1 class hour. 2 2-hour laboratory periods, credit, 3.
Dr. TORREY.

Prerequisite, Botany 3.

Elective Courses.

26. **II.** MORPHOLOGY AND TAXONOMY OF THE LOWER PLANTS (CRYPTOGAMIA). — Sophomores. Systematic study of typical forms of bacteria, algæ, fungi, lichens, mosses, ferns. (Courses 3, 25 and 26 constitute a general elementary course in botany, and are required of all students who major in the subject.)

1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor OSMUN and Dr. TORREY.

Prerequisite, Botany 25.

27. **III.** THE VASCULAR PLANTS. — For sophomores; juniors and seniors may elect. This course continues the work of Botany 26, but deals with the higher plants, such as ferns and fernworts, gymnosperms and angiosperms. The department possesses a unique collection of lantern slides and microscopical preparations for use in this course.

1 class hour. 2 2-hour laboratory periods, credit, 3.
Dr. TORREY.

Prerequisite, Botany 26.

50. **I.** DISEASES OF CROPS. — For juniors; seniors may elect. The lectures are general and are taken by all who elect the course, but in order to permit students to specialize on the diseases of crops most closely related to their majors or in which they are most interested, the course is divided for laboratory work into the following sections: (I) diseases of truck and field crops; (II) diseases of floricultural crops and ornamentals; (III) diseases of fruit crops; (IV) diseases of shade and forest trees. One, two or three laboratory sections may be taken.

1 class hour. 1, 2 or 3 2-hour laboratory periods, credits, 2, 3 or 4.
Assistant Professor MCLAUGHLIN.

Prerequisites, Botany 3 and 25.

51. **II.** DISEASES OF CROPS. — For juniors; seniors may elect. As stated under Course 50.

1 class hour. 1, 2 or 3 2-hour laboratory periods, credits, 2, 3 or 4.
Assistant Professor MCLAUGHLIN.

Prerequisite, Botany 50.

52. **I.** SYSTEMATIC MYCOLOGY. — For juniors; seniors may elect. Morphology and development of typical species representing the orders and families of fungi; practice in identification, collection and preservation of fungi; study

of systems of classification; collateral reading. A prerequisite of the senior course in plant pathology, but open to all.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Anderson.
Prerequisite, Botany 26.

53. **II.** Systematic Mycology. — For juniors; seniors may elect. As stated under Course 52.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Anderson.
Prerequisite, Botany 52.

54. **III.** Systematic Mycology. — For juniors; seniors may elect. As stated under Course 52.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Anderson.
Prerequisite, Botany 53.

55. **I.** Plant Histology. — For juniors; seniors may elect. Comparative study of the tissues of plants; training in histological methods, including the use of precision microtomes, methods of killing, fixing, sectioning, staining and mounting; collateral reading and conferences. This course offers valuable training in preparation for further work in botany.
3 2-hour laboratory periods, credit, 3.
Professor Osmun and Assistant Professor McLaughlin.
Prerequisites, Botany 3 and 25.

56. **II.** Plant Histology. — For juniors; seniors may elect. As stated under Course 55.
3 2-hour laboratory periods, credit, 3.
Professor Osmun and Assistant Professor McLaughlin.
Prerequisite, Botany 55.

75. **I.** Plant Pathology. — Seniors. Comprehensive study of diseases of plants; training in laboratory methods and technique, including culture work and artificial inoculation of hosts; miscellaneous diagnosis; study of literature and representative life histories of pathogens. Prepares for civil service, experiment station and college work.
1 class hour. 4 2-hour laboratory periods, credit, 5.
Professors Osmun and Anderson.
Prerequisite, Botany 54.

76. **II.** Plant Pathology. — Seniors. As stated under Course 75.
1 class hour. 4 2-hour laboratory periods, credit, 5.
Professors Osmun and Anderson.
Prerequisite, Botany 75.

77. **III.** Plant Pathology. — Seniors. As stated under Course 75.
1 class hour. 4 2-hour laboratory periods, credit, 5.
Professors Osmun and Anderson.
Prerequisite, Botany 76.

78. **I.** Plant Physiology. — Seniors. Study of the factors and conditions of (*a*) Plant Nutrition, including the taking up of water and mineral substances, the assimilation of carbon and nitrogen, and the release of energy due to the processes of dissimilation; (*b*) Plant Growth, including the influence of internal and external factors on growth, the development of reproductive and vegetative organs, and touching on plant inheritance and the origin of new varieties; (*c*) Plant Movements, including those due to the taking up of water, and those movements of both motile and fixed forms in response to external stimuli. Special emphasis is laid on the development of skill in the manipulation of apparatus in the laboratory; weekly conferences are held at which students report on assignments to a large range of original papers.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Assistant Professor Clark.
Prerequisites, Botany 26 and Chemistry 51.

79. **II.** Plant Physiology. — Seniors. As stated under Course 78.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Assistant Professor Clark.
Prerequisite, Botany 78.

80. **III.** Plant Physiology. — Seniors. As stated under Course 78.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Assistant Professor Clark.
Prerequisite, Botany 79.

82. **II.** Cytology and Embryology. — Seniors. Morphology and physiology of the cell; cell-division; embryonal development.
3 2-hour laboratory periods, credit, 3.
Assistant Professor McLaughlin.
Prerequisites, Botany 26 and 55.

83. **III.** Cytology and Embryology. — Seniors. As stated under Course 82.
3 2-hour laboratory periods, credit, 3.
Assistant Professor McLaughlin.
Prerequisite, Botany 82.

86. **I.** 87. **II.** 88. **III.** Seminar. — For seniors and graduate students. Presentation and discussion of important current botanical papers. A major requirement.
1 class hour. Credit, 1.
The Department.

General and Agricultural Chemistry.

Professor Lindsey, Professor Wellington, Professor Chamberlain, Professor Peters, Professor ———, Assistant Professor Serex.

In teaching the courses in chemistry, emphasis is laid on both their educational and their vocational value. The courses in the freshman year are intended to deal with fundamental principles, and to give the student such an understanding of the subject as will enable him to apply it in farm practice. The more advanced courses, including quantitative analysis and organic, physiological and physical chemistry, are intended primarily for those who intend to become teachers and workers in the allied sciences, or who desire to follow agricultural chemistry as a vocation. Advanced training is given by means of postgraduate courses (see Graduate School).

Those completing the undergraduate courses are fitted for positions in the agricultural industries, — fertilizer, feed and insecticide manufacture, — as well as in other lines of industry, and in the State experiment stations and in commercial laboratories. Postgraduate students are prepared for positions as teachers in high schools and colleges, and for more advanced positions in industry and in the experiment stations. All men who were worthy of recommendation have secured positions.

An entire building is devoted to the needs of the department. The basement is used for the storage of apparatus and chemicals. The first floor contains laboratories for organic, physiological and physical chemistry, and qualitative analysis. The second floor is occupied by the general lecture room, the reading room, offices for the several members of the staff, and laboratories for analytical chemistry. The third floor has desk room and hoods sufficient to accommodate 90 students at one time in general chemistry. On this floor is also a lecture room seating 56 students.

The entire laboratory is well equipped with the necessary apparatus and chemicals for all students who desire to perfect themselves as expert chemists, or who wish to study chemistry as a supplement to some other kind of practical or scientific work. The equipment includes a valuable and growing collection of specimens and samples of minerals, soils, raw and manufactured fertilizers, foods, milk products, fibers, various other vegetable and animal products, and artificial preparations of mineral and organic compounds; and also a series of preparations for illustrating the various stages of different manufactures from raw material to finished product.

Required Courses.

1. **I.** General Chemistry. — Freshmen. An introduction to the fundamental chemical laws, together with a study of the common acid-forming elements and their compounds. Textbook, Kahlenberg's "Outlines of Chemistry." This course is for those students who do not present chemistry for entrance, and who begin the subject in college.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Peters and Assistant Professor Serex.

2. **II.** General Chemistry. — Freshmen. A continuation of Course 1. A study of metals and their compounds. The laboratory work is the same as described under Course 4.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Peters.

3. **III.** Inorganic Agricultural Chemistry. — Freshmen. As stated under Course 5, **II.**
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Serex.

4. **I.** Advanced General Chemistry. — Freshmen. A review of the fundamental chemical laws, together with the common acid and base-forming elements and their compounds. Textbook, Kahlenberg's "Outlines of Chemistry." The laboratory work takes the synthetic form. Substances of agricultural importance are prepared in quantity and studied in detail by the student. These include ammonium sulfate, superphosphate, muriate and sulfate of potash, arsenate of lead, Paris green, Bordeaux mixture, lime-sulfur and emulsions.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Serex.
Prerequisite, Entrance Chemistry.

5. **II.** Inorganic Agricultural Chemistry. — Freshmen. A study of the chemical composition, properties and reactions of soils, fertilizers, fungicides and insecticides. The laboratory work is divided into three parts, as follows: (*a*) qualitative examination of soil, plant ash and superphosphate; (*b*) approximate quantitative determination of moisture, ash, carbonic acid, phosphoric acid, potash, etc.; (*c*) special work on retention of salts by soil, leaching of lime from the soil by carbonated water, etc.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Serex.

6. **III.** Organic Agricultural Chemistry. — Freshmen. The course embraces the study of the most important groups of organic compounds of plants and animals, the composition of plants, the chemistry of plant growth, plants as food and as industrial material, the composition of animals, the chemistry of digestion, also the study of some of the products related to plants and animals, such as milk, butter, cheese, sugar and alcohol. The treatment of the subject will be general, avoiding (so far as possible) complicated chemical facts and relationships, and endeavoring simply to make the student acquainted with the general chemistry of plants and animals and agricultural processes and products.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Chamberlain.

Elective Courses.

25. **I.** Qualitative Analysis. — *Basic.* — Sophomores. A course in the systematic analysis of metallic salts, presented from the ionic viewpoint. The student studies closely the tests used in the separation and identification of the metals; he then applies these tests to unknown mixtures. Text, Medicus' "Qualitative Analysis," with Stieglitz's "Qualitative Analysis" and Gooch & Browning's "Qualitative Analysis" for reference. This course should be taken, particularly, by all intending to follow chemistry as a vocation.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Serex.
Prerequisite, Chemistry 3 or 6.

26. **II.** QUALITATIVE ANALYSIS. — *Acidic.* — Sophomores. A continuation of Course 25.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor SEREX.

27. **III.** QUANTITATIVE ANALYSIS. — For sophomores; juniors and seniors may elect. Instruction in this course includes the gravimetric and volumetric determinations of some of the commoner metals and non-metals. Talbot's "Quantitative Chemical Analysis" is used as a text.
1 class hour. 2 4-hour laboratory periods, credit, 5.
Professors WELLINGTON and PETERS.
Prerequisite, Chemistry 25. Course 26 is prerequisite for those majoring in chemistry.

30. **III.** ORGANIC AGRICULTURAL CHEMISTRY. —For sophomores; juniors and seniors may elect. As described in Course 6. To be elected by those who have not had Chemistry 6.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor CHAMBERLAIN.

51. **I.** ORGANIC CHEMISTRY. — For juniors; seniors may elect. This course consists of a systematic study, both from texts and in the laboratory, of the more important compounds in the entire field of organic chemistry. Especial attention is given to those compounds which are found in agricultural products or are manufactured from them. These include alcohols, acids, esters, fats, carbohydrates and proteins. The work forms a foundation for courses in physiological chemistry and agricultural analysis, and is especially planned for those majoring in chemistry or the other sciences. Those electing Course 51 are expected to elect Course 52.
5 class hours. 2 3-hour laboratory periods, credit, 8.
Professor CHAMBERLAIN.
Prerequisites, Chemistry 3 or 6, and Chemistry 27 for those majoring in chemistry.

52. **II.** ORGANIC CHEMISTRY. — For juniors; seniors may elect. A continuation of Course 51, dealing principally with compounds of the benzene series.
5 class hours. 2 3-hour laboratory periods, credit, 8.
Professor CHAMBERLAIN.

62. **III.** ADVANCED QUANTITATIVE ANALYSIS. — For juniors; seniors may elect. Advanced work on subjects as stated under Course 27, together with the analysis of insecticides or the analysis of soils and fertilizers.
1 class hour. 2 4-hour laboratory periods, credit, 5.
Professors WELLINGTON and PETERS.
Prerequisite, Chemistry 27.

65. **III.** PHYSICAL CHEMISTRY. — For juniors; seniors may elect. A résumé of general chemistry from the viewpoint of physical chemistry, and the application of physical chemistry to agricultural chemistry.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Assistant Professor SEREX.
Prerequisite, Chemistry 27.

76. **I.** Milk and Butter Analysis. — For seniors; juniors may elect. A study of milk and butter analytically.
1 class hour. 2 4-hour laboratory periods, credit, 5.
Professor Peters and Assistant Professor Julian.
Prerequisite, Chemistry 27.

77. **II.** Cattle Feed, Water and Miscellaneous Analysis. — For seniors; juniors may elect. The analysis of cattle feeds and water, with interpretations. Other materials may be analyzed.
1 class hour. 2 4-hour laboratory periods, credit, 5.
Professor Peters and Assistant Professor Julian.
Prerequisite, Chemistry 27.

80. **I.** Physiological Chemistry. — Seniors. This course is intended to be supplementary to Courses 51 and 52. To those who expect to take up scientific work in microbiology, botany, agronomy, animal husbandry, etc., and who have had Courses 51 and 52, it will give acquaintance with the chemistry of the physiological processes in plants and animals, by means of which some of the important organic compounds studied in Courses 51 and 52 are built up in the living organism or are used as food by it. In the lectures the study of food and nutrition as related to both human and domestic animals is the principal subject. In the laboratory experimental studies are made of the animal body and the processes and products of digestion, secretion and excretion.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Chamberlain.

87. **III.** History of Chemistry. — Seniors. An exposition of the development of chemical knowledge from the earliest times to the present. Although the entire history will be included, the larger portion of it will receive only brief mention in order that the questions of vital interest in modern life and industry may be studied at greater length. Particular attention will be given to the questions of plant and animal industry. Chemists are strongly advised to take this course.
3 class hours. Credit, 3.
Professor Wellington.

90. **II.** Special Work in Agricultural Chemical Analysis. — Seniors. The student is given a problem to solve either in analytical chemistry or related to the agricultural industries. This is to acquaint him with the methods used in research and with the literature, and show him how to handle problems in this field of chemistry when occasion arises.
6 or 10 laboratory hours, credit, 3 or 5.
Professor Peters.

91. **III.** Special Work in Agricultural Chemical Analysis. — Seniors. As stated in Course 90.
10 laboratory hours, credit, 5.
Professor Peters.
Prerequisite, Chemistry 90.

92. **II.** Special Work in Physiological and Organic Agricultural Chemistry. — Seniors. In this course, as in Courses 90 to 95, the student will be able to give his attention primarily to one line of chemical study. To those whose tastes and interests are in connection with the organic and physiological problems of agricultural chemistry, many subjects of study present themselves, among which may be mentioned: proteins, carbohydrates, fats, organic nitrogenous compounds in fertilizers and soils and their relation to plants, the commercial production of alcohol from agricultural products, dyes, digestion and dietary studies, the chemical study of dairy products, etc.
6 or 10 laboratory hours, credit, 3 or 5.
Professor Chamberlain.
Prerequisites, Chemistry 51, 52 and 80.

93. **III.** Special Work in Physiological and Organic Agricultural Chemistry. — Seniors. As stated under Course 92.
10 laboratory hours, credit, 5.
Professor Chamberlain.
Prerequisite, Chemistry 92.

94. **II.** Special Work in Physical Chemistry. — Seniors. The field of agricultural chemistry offers many problems that have been attacked through the methods of physical chemistry; such, for example, are the hydrolysis of salts and of minerals and the absorption of salts and fertilizers by soils. Each student will select one line of work and follow it through the course, repeating some of the original work.
6 or 10 laboratory hours, credit, 3 or 5.
Assistant Professor Serex.
Prerequisite, Chemistry 65.

95. **III.** Special Work in Physical Chemistry. — Seniors. As stated under Course 94.
10 laboratory hours, credit, 5.
Assistant Professor Serex.
Prerequisite, Chemistry 94.

Entomology.

Professor Fernald, Professor Crampton, Assistant Professor Regan.

The introductory Courses 26 and 27, taken together, present a comprehensive view of the relation of insects to man, particularly as crop pests. The most important pests are carefully studied, together with the methods for their control. Courses 50 and 51 are arranged for special study of the pests of any one line of agricultural or horticultural occupation, selected by the student according to his plan of future work, with the intent of making him thoroughly familiar with the pests he will meet in his selected work after graduation, and the means of controlling them. The remaining courses are for the training of men as State or experiment station entomologists; for those going into the care of trees, etc., on estates, or for cities and towns; and as entomological experts, for which the demand has been very large.

A recently erected building provides excellent lecture rooms and laboratories. The laboratories are provided with individual desks, equipped with microscopes and all needed apparatus of all kinds. Dissecting microscopes, binoculars, microtomes, photographic apparatus, glassware and reagents are available for use and electric light and gas are connected with each desk. Two laboratories, one for juniors and seniors, the other for graduate students, are thus equipped. A department library containing all the more important works on insects, supplemented by others on the subject in the main library, and by the private libraries of the professors, make available more than 25,000 books and pamphlets on this subject. In addition, all the current magazines are received and their files are accessible to every one. A card catalogue giving references to the published articles on different insects contains about 65,000 cards, and is probably the largest index of its kind in the world. Spray pumps, nozzles and spraying appliances of all kinds are in use in various parts of the courses, and a large collection of insecticides is accessible for study. Photographic rooms are specially prepared for the photography of insects, and the greenhouses, gardens, orchards and the grounds of the college provide wide opportunities for the study, under natural conditions, of insect pests.

Elective Courses.

26. **II.** 27. **III.** General and Economic Entomology. — For sophomores; juniors and seniors may elect. This course is planned to meet the needs of students who desire some knowledge of insects, but who cannot give more than two terms to the subject. It also serves as an introduction to the later courses for those who intend to follow entomology farther. It touches briefly upon the structure of insects so far as this is needed for such a course; deals with metamorphosis, classification to the larger groups, and discusses the most important methods and materials used for control. The greater part of the time is devoted to special study of the most important insect pests, particularly of New England, showing their modes of life, the injuries they cause, and the best methods of control. In this way the most serious pests of fruit trees, ornamental trees and shrubs, market-garden and greenhouse pests, those attacking field crops and those affecting animals and man, are treated. During the winter term and in the spring term until about the first of May instruction is given by lectures and recitations; from about the first of May field work takes the place of the lectures. In this part of the course the students are shown how to find and recognize the work of the various insect pests which may be accessible at that season of the year, and they also make and preserve a collection of insects.

3 class hours. Credit, 3.

Professor Fernald.

27. **III.** General and Economic Entomology. — As stated under Course 26, **II.**

2 class hours till about May 1; thereafter 2 2-hour field periods. Credit, 2.

Professors Fernald, Crampton and Regan.

50. **I.** Pests of Special Crops. — For juniors; seniors may elect. For students not majoring in entomology, and also for those majoring in entomology. The laboratory work is largely individual in this term. Accordingly, students majoring in subjects other than entomology, but who desire a more complete knowledge of the insects connected with their own major line of work, can obtain it here. A student majoring in floriculture, for example,

will devote his laboratory time to a careful study of the insects injuring floricultural crops, learning how to recognize them and their work in their different stages, and the best methods for their control. Courses of this kind are available on the insects attacking field crops, market-garden crops, tree fruits, small fruits, shade trees and shrubs, flowers, forest trees, the domesticated animals, household pests and man. This work may be continued in the winter term also. (See 51, **II.**)

3 2-hour laboratory periods, credit, 3.
Professor Fernald.

Prerequisites, Entomology 26 and 27.

51. **II.** Pests of Special Crops. — As stated in 50, **I.** For students not majoring in entomology. Those who were not able to take Entomology 50 in the fall may take it here. Those who took Entomology 50 in the fall have an opportunity to continue the work during this term also.

3 2-hour laboratory periods, credit, 3.
Professor Fernald.

52. **II.** Insecticides and their Application. Classification o Insects. — For juniors majoring in entomology. Lectures on the composition, preparation and methods of application of insecticides. Laboratory work on classification of insects, particularly those for which insecticides are used.

1 class hour. 2 2-hour laboratory periods, credit, 3.
Professors Fernald and Regan.

Prerequisite, Entomology 53.

53. **I.** Insect Morphology. — For juniors majoring in entomology. The lectures of this course treat of the external and internal anatomy of insects, particularly of those characters used in identification, a knowledge of which is needed in the accompanying laboratory work. In the laboratory the external anatomy of the most important groups is studied, followed by the identification of insects of these groups, to show how the characters are made use of in learning the names of insects, and to teach the use of analytical keys.

2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor Crampton.

Prerequisites, Entomology 26 and 27.

54. **II.** Insect Classification. — For juniors majoring in entomology. Systematic identification of insects of various groups. Study of various entomological publications and methods of finding the literature on any insect.

3 2-hour laboratory periods, credit, 3.
Assistant Professor Regan.

Prerequisite, Entomology 53.

55. **III.** Economic Entomology. — For juniors majoring in entomology. Continuation of lectures on insecticides; laboratory work on the identification of insect pests, both as adults and in their early stages.

1 class hour. 2 2-hour laboratory periods, credit, 3.
Professors Fernald, Crampton and Regan.

Prerequisites, Entomology 52 and 53.

75. **III.** Forest and Shade-tree Insects. — For juniors; seniors may elect. The lecture work deals with the principles and methods of controlling insects which attack forests and forest products, shade trees, etc. The laboratory periods are devoted to a study of the more important species, their identification, biology and specific control measures. Field work will supplement laboratory study if time permits.

1 class hour. 3 2-hour laboratory or field periods, credit, 4.
Assistant Professor Regan.
Prerequisites, Entomology 26 and 27; 53 and 54 desirable.

76. **I.** Advanced Entomology. — For seniors. Studies on insect bionomics; scale insects, their structure, habits, methods of mounting, identification, etc.; studies of the animals not insects with which entomologists are expected to deal.

2 class hours. 3 2-hour laboratory periods, credit, 5.
Professors Crampton and Regan.
Prerequisite, Entomology 55.

77. **II.** Advanced Entomology. — Studies of the life history, habits and methods of control of the important insect pests of the United States; recognition tests of these pests and an examination of the literature on them; methods of bulletin preparation.

3 2-hour laboratory periods, credit, 3.
Assistant Professor Regan.
Prerequisite, Entomology 76.

78. **III.** Advanced Entomology. — Insects as disease carriers; classification of the minor orders of insects; principles of classification, the use of literature on entomology and the preparation of bibliographies and indices; the enemies of insects.

1 class hour. 3 2-hour laboratory or field periods, credit, 4.
Professors Fernald, Crampton and Regan.
Prerequisite, Entomology 77.

90. **II.** Evolution. — For juniors; seniors may elect. In order to demonstrate the universal scope and operation of the laws of evolution, the course includes a brief sketch of the probable origin and evolution of matter as viewed in the light of modern physical and chemical research; the evolution of the solar system, leading to the formation of the earth; the changes in the earth, preparatory to the production of life; the physical and chemical basis of life; the probable steps in the formation of living matter, and the theories concerning it; the evolution of living things; the developmental history of man, and of the races of mankind, the evolution of human intelligence, languages, culture, institutions, etc., and man's probable future in the light of his past development. Especial consideration is given to the factors of evolution, the basic principles of heredity, sex-determination, variation and similar topics, with particular reference to their application to human welfare; and the recent contributions in the field of entomology to the advancement of our knowledge of these fundamental principles are briefly reviewed.

3 class hours. Credit, 3.
Professor Crampton.

Mathematics and Civil Engineering.

Professor Ostrander, Professor Machmer, Assistant Professor Moore, Mr. Clark.

The work of the freshman year is required. It is intended to furnish the necessary drill and groundwork needed for many of the scientific and practical courses of other departments. Thoroughness and accuracy are insisted upon. The advanced work in mathematics is taught from a practical standpoint, and many of its applications to other subjects are given. The courses in surveying and civil engineering are given to furnish the groundwork for a professional career. Special emphasis is given to the subjects bearing on highway construction and maintenance.

For drawing, a room on the north side is used for the draughting. It has draughting tables, T squares, scales, etc., for twenty students. Vernier protractors, parallel rules and steel T squares are available for precise work. A small room is devoted to blue printing.

In surveying, the department has a considerable number of chains and tapes, two railroad compasses, a builder's level, two dumpy levels, two Y levels and two old levels used for teaching the adjustments. Six transits are available for student use. Two are provided with solar attachments. An omnimeter with vernier reading to ten seconds is available for geodetic work. A hand level, mining aneroid barometer, and prismatic compass are provided for reconnoissance work. A set of Gilmore's needles and a Fairbanks' machine are used for cement testing.

Required Courses.

1. **I.** Higher Algebra. — Freshmen. A brief review of radicals, quadratic equations, ratio and proportion, and progressions; graphs, binomial theorem, undetermined coefficients, summation of series, variation, continued fractions, determinants, permutations and combinations, logarithms, theory of equations. Reitz and Crathorne's "College Algebra."
5 class hours. Credit, 5.
The Department.

2. **II.** Higher Algebra. — As stated under Course 1.
2 class hours. Credit, 2.
The Department.

3. **III.** Solid Geometry. — Freshmen. Theorems and exercises on the properties of straight lines and planes, dihedral and polyhedral angles, prisms, pyramids and regular solids; cylinders, cones and spheres; spherical triangles and the measurement of surfaces and solids. Wentworth and Smith's "Solid Geometry." Required unless accepted for admission.
3 class hours. Credit, 3.
The Department.

5. **II.** Plane Trigonometry (in charge of Department of Physics). — Freshmen. The trigonometric functions as lines and ratios; proofs of the principal formulas, transformations; inverse functions, use of logarithms;

the applications to the solution of right and oblique triangles; practical applications. Bowser's "Elements of Plane and Spherical Trigonometry."
3 class hours. Credit, 3.
Professors HASBROUCK and HARRINGTON.

6. **III.** MENSURATION AND COMPUTATION. — Freshmen. The course includes a review of methods of computation, with special emphasis on short and abbreviated processes, together with methods of checking computations and of forming close approximations; use of slide rule. Also the graph, mensuration of plane and solid figures, weights and measures and elementary mechanism. Numerous practical problems are selected from such subjects as the following: the mathematics of woodworking; rough lumber; general construction; forestry methods in heights of trees; pulleys, belts and speeds; power and its transmission; dairying; agronomy; computation of areas from simple measurements.
2 class hours. Credit, 2.
The DEPARTMENT.

Elective Courses.

26. **II.** PLANE SURVEYING. — For sophomores; juniors and seniors may elect. The elements of the subject, including the adjustment and use of the usual instruments. Textbook and lectures.
2 class hours. Credit, 2.
The DEPARTMENT.

27. **III.** PLANE SURVEYING. — For sophomores; juniors and seniors may elect. As stated under Course 26. Includes field work.
3 2-hour laboratory periods, credit, 3.
The DEPARTMENT.
Prerequisite, Mathematics 26.

50. **I.** ANALYTIC GEOMETRY. — For juniors; seniors may elect. A discussion of the geometry of the line, the circle, conic sections, and the higher plane curves. Fine and Thompson's "Co-ordinate Geometry."
3 class hours. Credit, 3.
The DEPARTMENT.
Prerequisites, Mathematics 1, 2, 3 and 5.

51. **II.** DIFFERENTIAL AND INTEGRAL CALCULUS. — For juniors; seniors may elect. A first course in the subject, with some of the more important applications. Granville's "Differential and Integral Calculus."
5 class hours. Credit, 5.
The DEPARTMENT.
Prerequisites, Mathematics 1, 2, 3 and 5.

52. **III.** INTEGRAL CALCULUS. — For juniors; seniors may elect. A continuation of Course 51.
5 class hours. Credit, 5.
The DEPARTMENT.
Prerequisite, Mathematics 51.

53. **II.** Elementary Structures. — For juniors; seniors may elect. An elementary course in roofs and bridges. Textbook and lectures.
3 class hours. 1 2-hour laboratory period, credit, 4.
The Department.

75. **I.** Hydraulics and Sanitary Engineering. — For seniors; juniors may elect. Hydrostatics, theoretical hydraulics, orifices, weirs, pipes, conduits, water supply, hydraulic motors, sewers and sewage treatment. Textbook and lectures.
5 class hours. Credit, 5.
The Department.

76. **I.** Materials of Construction, Foundations and Masonry Construction. — For seniors; juniors may elect. Textbook and lectures.
4 class hours. 1 2-hour laboratory period, credit, 5.
The Department.

77. **II.** Roads and Railroads. — For seniors; juniors may elect. Topographic and higher surveying, highway construction, earthwork, pavements and railroad construction. Textbook and lectures.
3 class hours. Credit, 3.
The Department.

78. **III.** Roads and Railroads. — For seniors; juniors may elect. As stated under Course 77.
3 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Mathematics 77.

79. **I.** Applied Mechanics. — Seniors. A course in applied mechanics, based on the calculus, with problems. Textbooks and lectures.
5 class hours. Credit, 5.
The Department.

Prerequisites, Mathematics 51, 52.

Microbiology.

Professor Marshall, Assistant Professor Itano, Mr. Neill.

Three objectives are sought in the arrangement of the courses following: (1) An introductory course (50) needed in the general training of every college student. (2) An introductory course (50) followed by a specific course (as 80, 81, 82, 83), necessary to every student engaged in the Division of Agriculture, with which the specific course deals. (3) An introductory course (50) followed by Courses 51, 52, 75, 76 and 81, preparatory for students who are aiming to specialize in agricultural microbiology. (Courses 75, 76 and 81 are adapted to those having Course 50 only, and are also adapted to those majoring in microbiology).

The microbiological work is housed in a newly constructed building especially designed for it. There are 4 class laboratory rooms, 8 private laboratory rooms, 1 lecture room, 5 incubator rooms, 3 sterilizing rooms, 3 hood rooms, 3 washing rooms, 3 inoculating rooms, 3 weighing rooms, an animal room, a photographic and a dark room, a sub-basement refrigerator room, a library and 4 office rooms.

The class laboratory rooms are so arranged that individual desks are available for student use. Hot and cold water and gas connections are convenient for each desk; high-pressure steam and electric connections are also available. The building is well lighted and of sanitary construction; all the walls are of brick, and the building is fireproof.

The library is equipped with such books and current periodicals as are useful in the conduct of bacteriological work and investigations. Twenty-four scientific magazines are available regularly.

There are incubators, both electric and gas, hot-air sterilizers, ordinary steam sterilizers, autoclaves, an inspissator, blood-testing apparatus, vacuum apparatus, air-pressure apparatus, shaker, grinder, centrifugal machines, a water still of 5 gallons per hour capacity, Hoskins' combustion furnace, a balopticon, complete microphotographic equipment, microscopes, microtome, and such other apparatus, glassware and chemicals as are needed for extensive and intensive work.

Elective Courses.

50. **I, II** and **III.** INTRODUCTORY AND GENERAL MICROBIOLOGY. — For juniors; seniors may elect. Aims to provide elementary basis for microbial studies and interpretation, to enable students to pursue special pertinent courses which will serve as supports in practical electives or majors, and to furnish students with such material as will be valuable in understanding public health problems. Three hours scheduled, five hours by arrangement.

2 class hours. 6 laboratory hours, credit, 5.

Professor MARSHALL and Mr. NEILL.

51. **II** and **III.** MORPHOLOGICAL, CULTURAL AND PHYSIOLOGICAL MICROBIOLOGY. — For juniors; seniors may elect. Types of micro-organisms, technic of handling, methods of culture and functions of micro-organisms are considered. This course is fundamental to all advanced and extended microbiological studies. One hour will be scheduled.

10 laboratory hours, credit, 5.

Mr. NEILL.

Prerequisite, Microbiology 50.

52. **III.** ADVANCED MORPHOLOGICAL, CULTURAL AND PHYSIOLOGICAL MICROBIOLOGY. — For juniors; seniors may elect. The purpose of this course is to prepare the student for a more intimate knowledge of microbiological agricultural problems. To accomplish this object it is necessary to provide more advanced technic and methods of culture, together with a more extensive knowledge of micro-organisms and their functions. One hour will be scheduled.

10 laboratory hours, credit, 5.

Assistant Professor ITANO.

Prerequisite, Microbiology 50.

75. **II.** AGRICULTURAL MICROBIOLOGY. — For seniors; juniors may elect. This general comprehensive course is designed to cover in an elementary manner those subjects only which confront the student of general agricul-

ture, — the microbiological features of air, water, sewage, soil, dairy, fermentations, food, vaccines, antisera, microbial plant infections, methods and channels of infections, immunity and susceptibility, microbial infections of man and animals, methods of control or sanitary and hygienic practices. One hour will be scheduled.

10 laboratory hours, credit, 5.
Assistant Professor Itano.

Prerequisite, Microbiology 50.

76. **III.** Agricultural Microbiology. — For seniors; juniors may elect. As stated under Course 75. One hour will be scheduled.

10 laboratory hours, credit, 5.
Assistant Professor Itano.

Prerequisites, Microbiology 50 and 75.

80. **II.** Soil Microbiology. — For seniors; juniors may elect. Such subjects as the number and development of micro-organisms in different soils; the factors which influence their growth, food, reaction, temperature, moisture and aeration; the changes wrought upon inorganic and organic matter in the production of soil fertility, ammonification, nitrification and denitrification; fixation of nitrogen symbiotically and non-symbiotically; methods of soil inoculation receive attention. One hour will be scheduled.

10 laboratory hours, credit, 5.
Assistant Professor Itano.

Prerequisite, Microbiology 50.

81. **I.** Hygienic Microbiology. — For seniors; juniors may elect. An attempt will be made to select for this course certain material which should be the possession of every individual, and which is basic to public hygiene and sanitation, as applied to man and animals. The microbiology of water supplies, food supplies, vaccines, antisera or antitoxins; the channels by which micro-organisms enter the body, the influence of body fluids and tissues upon them, body reactions with micro-organisms (susceptibility and immunity); the micro-organisms of some of the most important infectious diseases, methods of control, including disinfectants and disinfection, antiseptics, antisepsis and asepsis, will be treated. One hour will be scheduled.

10 laboratory hours, credit, 5.
Assistant Professor Itano.

Prerequisite, Microbiology 50.

82. **I.** Dairy Microbiology. — For seniors; juniors may elect. Special emphasis will be placed upon milk supplies. The microbial content of milk, its source, its significance, its control; microbial taints and changes in milk; groups or types of organisms found in milk; milk as a carrier of disease-producing organisms; the value of straining, aeration, clarification, centrifugal separation, temperature, pasteurization; the abnormal fermentations of milk; bacteriological milk standards and their interpretation; ripening of milk and cream; the bacterial content of butter; a passing survey of the microbiology

of cheeses; a study of special dairy products, as ice cream, condensed milk, artificial milk drinks (the products of microbial actions), represents a list of topics considered.

10 laboratory hours, credit, 5.
Professor Marshall and Mr. Neill.

Prerequisite, Microbiology 50.

83. **I.** Food Microbiology. — For seniors; juniors may elect. A study of the principles of food preservation, and food preservation by means of drying, canning, refrigerating and addition of chemicals, will be pursued. Food fermentations, as illustrated by bread, pickles, sauerkraut, ensilage, vinegar, wine, etc., will be examined. Decomposition of foods, as may be seen in meat, oysters, fish, milk, etc., as well as diseased and poisonous foods, will receive consideration. Contamination of food supplies by means of water, sewage, handling, exposure, diseased persons, etc., is of especial significance, and will be demonstrated by laboratory exercises. Laboratory inspection of foods is now a subject of great import and will be given attention. One hour will be scheduled.

10 laboratory hours, credit, 5.
Professor Marshall and Mr. Neill.

Prerequisite, Microbiology 50.

Special Courses for Women.

1. **I.** Elementary Microbiology. — For freshmen. The course will be devoted to the various types of micro-organisms, their distribution in nature and their characterization. Such methods as are essential for examination, manipulation and culturing will be studied and employed.

6 laboratory periods, credit, 3.
Professor Marshall and Mr. Neill.

In place of Military 1, tactics; Military 4, drill; fall term, freshmen.

3. **III.** Elementary Microbiology. — For freshmen. Continuation of 1.

4 laboratory periods, credit, 2.
Professor Marshall and Mr. Neill.

In place of Military 3, tactics; Military 6, drill; spring term, freshmen.

25. **I.** Personal Hygiene. — For sophomores. Such subjects as the hygiene of the mouth and teeth, the gastro-intestinal tract, food, the skin, respiration apparatus, ear, eye and nervous system are reviewed. The value of bathing, clothing, physical exercise, etc., are considered. Attention will be given to emergencies, accidents of "first aid," and such other matters as usually fall within this category.

2 class hours, credit, 2.
Professor Marshall.

In place of Military 25, tactics; Military 28, drill; fall term, sophomores.

27. **III.** Sanitary Science. — For sophomores. The usual topics of sanitary science, as ventilation, heating, plumbing, water supply, sewage disposal, food control and communicable diseases, will be treated wholly from the standpoint of individual and public health control.

2 class hours, credit, 2.
Professor Marshall.

In place of Military 27; Military 30; spring term, sophomores.

Physics.

Professor Hasbrouck, Professor Harrington, Mr. Tower.

The fundamental and basic importance of the laws and phenomena of physics makes necessary no explanation of the introduction of this subject into the curriculum of an agricultural college. The logical development of the subject emphasizes the importance of physics as a science in itself. Special emphasis is laid, however, on the correlation of the principles studied with the sciences of agriculture, botany, chemistry and zoölogy, thus furnishing an extra tool by use of which the student's work in all the subjects may be more effective.

In Courses 25, 26 and 27 the subject-matter is presented with the idea of its special application primarily in the work in agriculture and general science. The full year's work is advised for all students continuing work specifically in the Division of Science. Courses 25 and 26 are required of all students. Course 29 is advised for students expecting to do special work in farm mechanics or general farm practice. The subject-matter is especially selected and arranged for its practical application rather than its theoretical development. Courses 50, 51 and 52 are advised for students in chemistry, general biology, microbiology and general science. The subject-matter is selected, and the courses developed, with the idea of making the student proficient in laboratory manipulation. Sufficient theory is given in connection with the work to enable the student to apply the knowledge and practice thus gained in the departments indicated above.

The department has at its command a building on the east campus, containing a general lecture room and laboratory for sophomore work, a laboratory for junior work, and in the basement one small laboratory for quantitative work in light measurement. There is also in the basement a fairly well-equipped shop for the repair and construction of apparatus used in the department work. The usual apparatus for the demonstration in the lecture room is in the possession of the department. The laboratory equipment is such as to enable the department to offer qualitative work in mechanics, heat, electricity and light.

Required Courses.

25. **I.** General Physics. — Sophomores. Mechanics of solids and fluids. This course includes statics, with equilibrium of rigid bodies, work, energy and friction; kinetics, considering rectilinear motion and motion in a curved path; harmonic motion; rotation of rigid bodies, including kinematics of rotation; liquids and gases, with properties of fluids at rest and in motion; properties of matter and its internal forces, including elasticity, capillarity, surface tension.

3 class hours. 1 2-hour laboratory period, credit, 4.
Professors Hasbrouck and Harrington.

26. **II.** Electricity and Magnetism. — Sophomores. The work in electricity includes such subject-matter as magnetism, electrostatics, electric currents with their production, chemical, heating and mechanical effects; battery cells, measurement of voltage, current flow and resistance, motors and generators.

2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Harrington.

Elective Courses.

27. **III.** Heat and Light. — For sophomores; juniors and seniors may elect. Thermometry, expansion, colorimetry and specific heat, transmission of heat, changes of state, radiation and absorption. Wave theory of light, optical instruments, analysis of light, color, interference, diffraction, polarization.

4 class hours. 1 2-hour laboratory period, credit, 5.
Professors Hasbrouck and Harrington.

29. **III.** Applied Electricity. — For sophomores; juniors and seniors may elect. Wiring and testing of commercial equipment, such as storage cells, dynamos, motors, engine ignitors and distributors, heaters, transformers, etc. Laboratory work, accompanied by notes and required reading. Elective only by arrangement with instructor.

1 class hour. 2 2-hour laboratory periods, credits, 3.
Professor Harrington.

Prerequisite, Physics 26.

50. **I.** Electricity, Heat and Light. — For juniors; seniors may elect.

1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Harrington.

Prerequisite, Physics 27.

51. **II.** Electricity, Heat and Light. — For juniors; seniors may elect. Continuation of Course 50.

1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Harrington.

Prerequisite, Physics 50.

52. **III.** Electricity, Heat and Light. — For juniors; seniors may elect. Continuation of Courses 50 and 51.

1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Harrington.

Prerequisite, Physics 51.

Veterinary Science.

Professor Paige, Professor Gage.

The courses in veterinary science have been arranged to meet the needs (1) of students who propose following practical agriculture; (2) of prospective students of human and veterinary medicine; and (3) of teachers and laboratory workers in the biological sciences.

The department occupies a modern laboratory and hospital stable, built in accordance with the latest principles of sanitation. Every precaution has been taken in the arrangement of details to prevent the spread of disease, and to provide for effective heating, lighting, ventilation and disinfection.

The main building contains a large working laboratory for student use, and several small private laboratories for special work. There is a lecture hall, a museum, a demonstration room, a photographing room and a workshop. The hospital stable contains a pharmacy, an operating hall, a post-mortem and dissecting room, a poultry section, a section for cats and dogs, and 6 sections, separated from each other, for horses, cattle, sheep and swine. The laboratory equipment consists of a dissectible Auzoux model of the horse and Auzoux models of the foot and the leg, showing the anatomy and the diseases of every part. The laboratories also have modern, high-power microscopes, microtomes, incubators and sterilizers, for work in every department of veterinary science, including pathology, serology and parasitology. There are skeletons of the horse, the cow, the sheep, the dog and the pig, and a growing collection of anatomical and pathological specimens. The lecture room is provided with numerous maps, charts and diagrams.

Elective Courses.

50. I. VETERINARY HYGIENE AND STABLE SANITATION. — For juniors; seniors may elect. This course is intended to familiarize the student with the relation of water, food, air, light, ventilation, care of stables, disposal of excrement, individual hygiene, etc., to the prevention of disease in farm animals.
5 class hours. Credit, 5.
Professor PAIGE.

51. I. COMPARATIVE (VETERINARY) ANATOMY. — For seniors; juniors may elect. The anatomy of the horse is studied in detail, and that of other farm animals compared with it where differences exist. This course is essential for those students wishing to elect Course 76.
5 class hours. Credit, 5.
Professor PAIGE.

75. II. GENERAL VETERINARY PATHOLOGY. MATERIA MEDICA AND THERAPEUTICS. — For juniors; seniors may elect. In this course such fundamental and general pathological conditions are studied as inflammation, fever, hypertrophy, atrophy, etc., a knowledge of which is essential in the diagnosis, prevention and treatment of disease. The course in pathology is followed by one in materia medica and therapeutics, dealing with the origin, preparation, pharmacology, pharmacy, administration and therapeutic use of the more common drugs. Poisonous plants and symptoms and treatment of plant poisoning are also considered.
5 class hours. Credit, 5.
Professor PAIGE.

76. II. THEORY AND PRACTICE OF VETERINARY MEDICINE; GENERAL, SPECIAL AND OPERATIVE SURGERY. — For seniors; juniors may elect. A course intended to familiarize the student with the various medical and surgical diseases of the different species of farm animals. Particular attention is given to diagnosis and first-aid treatment. The student is taught the technique

of simple surgical operations that can with safety be performed by the stock owner. Lectures, demonstrations and practice. This course should be taken in conjunction with Course 51.

5 class hours. Credit, 5.

Professor Paige.

Prerequisite, Veterinary 75.

78. **I.** Essentials of General Pathology. — For seniors; juniors may elect. This course is planned to introduce the student to some of the essential anatomical, histological and general physiological phenomena essential to the understanding of some of the simple general pathological conditions found in domestic animals. Some of the common methods of diagnosis will be considered in the laboratory. The various chemical and biological reactions and tests will be presented from the standpoint of pure science, showing applications of chemistry and biology. The course will serve to liberally educate and stimulate in the student of agriculture the appreciation of some of the methods used in animal pathology for detecting and controlling some of the more common animal diseases. Lectures, demonstration and laboratory work.

2 3-hour laboratory periods, credit, 3.

Professor Gage.

79. **II.** Essentials of General Animal Pathology. — For seniors; juniors may elect. This is a continuation of Course 78, and is devoted to a study of some of the common pathological conditions by means of prepared sections, the aim being to demonstrate to the student abnormal animal histological structures commonly observed when material from various cases of animal diseases is prepared for microscopical study. Some of the biological products used in protecting animals against disease will be considered.

2 3-hour laboratory periods, credit, 3.

Professor Gage.

Prerequisite, Veterinary 78.

80. **III.** Essentials of General Animal Pathology. — For seniors; juniors may elect. As stated in Courses 78 and 79.

2 3-hour laboratory periods, credit, 3.

Professor Gage.

Prerequisite, Veterinary 79.

85. **I.** Avian Pathology. — For seniors; juniors may elect. A course in poultry diseases. The object of this course is to present information concerning the common diseases of poultry, their etiology, diagnosis and prevention. The work will consist of a systematic study of the diseases of the alimentary tract, liver and abdominal region, followed by a study of the diseases of the respiratory system, circulation and kidneys. The important disease-producing external and internal parasites will be considered; also diseases of the skin and reproductive organs. Lectures and demonstrations.

2 3-hour laboratory periods, credit, 3.

Professor Gage.

86. **II.** Avian Pathology. — For seniors; juniors may elect. As stated under Course 85, also devoted to the study of some of the special diseases of poultry. Recent methods used in the control of these diseases will be considered and opportunity offered the student for demonstrating various disease processes by means of prepared slides. Lectures, demonstrations and laboratory work.
2 3-hour laboratory periods, credit, 3.
Professor Gage.

Prerequisite, Veterinary 85.

87. **III.** Avian Pathology. — For seniors; juniors may elect. As stated under Courses 85 and 86.
2 3-hour laboratory periods, credit, 3.
Professor Gage.

Prerequisite, Veterinary 86.

Zoölogy and Geology.

Professor Gordon, Dr. Abbott.

The elective courses in zoölogy and geology in practice generally stand as offerings available to students who wish either to supplement their work in other departments or to continue their work in zoölogy or geology. They have definite objectives, either as supporting subjects or as courses designed to enlarge the student's knowledge in the subject pursued.

The building occupied jointly by the department of entomology and the department of zoölogy and geology has for the work in zoölogy and geology spacious laboratories equipped with gas, compound microscopes and the accessories needed for study, research and demonstration in these subjects. There are two commodious lecture rooms, used jointly by the two departments. The Zoölogical Museum has a representative collection of several thousand specimens of animals, and is drawn upon for material illustrating the various courses. The curator is Professor Gordon.

ZOÖLOGY.

Required Course.

25. **I.** Principles of Zoölogy. — Sophomores.
2 class hours. 2 2-hour laboratory periods, credit, 4.
Professor Gordon and Dr. Abbott.

Elective Courses.

27. **III.** Elements of Mammalian Anatomy. — Sophomores; juniors and seniors may elect.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Gordon.

50. **I.** Synoptic Invertebrate Zoölogy. — Juniors; seniors may elect.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Dr. Abbott.

Prerequisite, Zoölogy 25.

51. **II.** SYNOPTIC INVERTEBRATE ZOÖLOGY. — Juniors; seniors may elect. Continuation of Course 50.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Dr. ABBOTT.
Prerequisite, Zoölogy 50.

52. **III.** SYNOPTIC INVERTEBRATE ZOÖLOGY. — Juniors; seniors may elect. Continuation of Course 51.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Dr. ABBOTT.
Prerequisite, Zoölogy 51.

53. **I.** ELEMENTS OF MICROSCOPIC TECHNIQUE. — Juniors; seniors may elect.
3 2-hour laboratory periods, credit, 3.
Professor GORDON.

54. **II.** ELEMENTS OF HISTOLOGY. — Juniors; seniors may elect.
3 2-hour laboratory periods, credit, 3.
Professor GORDON.
Prerequisite, Zoölogy 53.

55. **III.** ELEMENTS OF HISTOLOGY. — Juniors; seniors may elect.
3 2-hour laboratory periods, credit, 3.
Professor GORDON.
Prerequisite, Zoölogy 54.

58. **II.** CONSERVATIONAL ZOÖLOGY. — Juniors; seniors may elect. For students who are interested in the conservation of wild life, especially the natural fauna of the State. Not offered for the year 1919–20.
2 class hours. 1 2-hour laboratory period, credit, 3.
The DEPARTMENT.

75. **I.** SPECIAL ZOÖLOGY. — Juniors, seniors, graduates and others may apply for such special work as they are qualified to undertake.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

76. **II.** SPECIAL ZOÖLOGY. — Same as Course 75.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

77. **III.** SPECIAL ZOÖLOGY. — Same as Course 75.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

78. **II.** ORNITHOLOGY. — Juniors, seniors and others. The taxonomic characters, migrations and distribution of the birds.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

79. **III.** Economic and Field Ornithology. — A review and study in the field of the food and other habits of Massachusetts birds.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Geology.

Required Course.

2. **II.** Agricultural Geology. — Freshmen.
2 class hours. Credit, 2.
Professor Gordon.

Elective Course.

27. **III.** General Geology. — Sophomores; juniors and seniors may elect.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Gordon.

DIVISION OF THE HUMANITIES.

Professor SPRAGUE.[1]

Economics and Sociology.

Professor SPRAGUE.[1]

Courses in 1920–21, given by Assistant Professor Parker, Acting Head of the Department, assisted by Professors Tyler and Crook of Amherst College, and Professor Sims.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

The courses in economics and sociology are planned with the purpose of giving the student that knowledge and understanding of the important factors and problems in this field of study and life which every active citizen and educated man ought to have.

Elective Courses.

26. **II.** CIVILIZATIONS, ANCIENT AND MODERN. — For sophomores; others may elect. This course studies the evolutionary origin and history of man; characteristics of primitive man, departure from the animal status and beginnings of civilization; origin and development of industries, arts and sciences; the evolution of languages, warfare, migrations and social institutions; a study of the powerful natural and human forces that have brought man from the early stages to modern development; characteristic features of the leading civilizations and races of ancient and modern times; beneficial and dangerous factors in American life in view of the history of human civilization.
5 class hours. Credit, 5.
Professor TYLER.

50. **II.** BUSINESS AND INDUSTRY. — For juniors and seniors. The forms, organization, administration and labor problems of business. This course is devoted to the following subjects: methods of organizing, financing and administering corporations and partnerships; forms of business administration, wholesaling, jobbing, retailing, advertising, credits and collections; systems of industrial remuneration for wage earners, co-operation and preserving industrial peace; problems concerned with protective legislation for workmen and employers, sweated industries, prison labor, child labor and industrial education.
5 class hours. Credit, 5.
Professor CROOK.

51. **I.** INTRODUCTION TO ECONOMIC PRINCIPLES AND PROBLEMS. — For juniors. This course is devoted to the study of the following subjects: definitions of economic terms, such as wealth, capital, value, etc.; factors of production, exchange and consumption; principles of economic production, supply and demand, diminishing returns, division of labor, productive organization, concentration of capital and labor, trust and monopoly problems, public control of production and distribution; principles of exchange, theories of value,

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[1] On leave of absence, 1920–21.

money and its problems; international trade, tariff and free trade theories, American merchant marine, reciprocity, and trade treaties; forms of income, wages, interest, rent, profits and the forces which govern them; principles of spending, economy, luxury, conservation of individual and national resources; principles and agencies for saving, investments, banks, building associations, insurance of all kinds; schemes for social organization; socialism, communism, industrial democracy. Textbook and readings.
5 class hours. Credit, 5.
Professor CROOK.

75. **I.** SOCIAL INSTITUTIONS AND SOCIAL REFORMS. — For seniors; juniors by permission. This course is devoted to the study of the social institutions, such as the family, the State, property, religions; and to such current problems as eugenics, race suicide, divorce, crime and delinquent classes, prison reform, prevention and treatment of dependents and defectives, poverty, its causes and preventions; constructive modern social reform movements for insurance of wage earners, protection of childhood, assurance of safety, health and play time for all classes. The correctional and charitable institutions of Massachusetts will be studied in considerable detail.
5 class hours. Credit, 5.
Professor SIMS.

77. **III.** PUBLIC FINANCE, TAXATION, MONEY AND BANKING. — For seniors. This course studies systems and problems of taxation as they are found in Europe and America; objects for spending public revenue; public debts and methods of organizing them; systems of money and currency problems of America; types, methods and functions of banks; economic and financial crises and depressions in the United States; modern war finance. Readings and lectures.
5 class hours. Credit, 5.
Professor CROOK.

History and Government.

Assistant Professor PARKER.

Elective Courses.

50. **III.** GOVERNMENT. — For juniors; seniors may elect. This course will cover subjects as follows: forms and working methods of the governments of Great Britain, Germany, France, Russia, Switzerland, New Zealand and Canada; historic types and theories of government; forms and methods of Federal, State and local governments in America; progress and problems of democracy and new reform movements in organization and administration; new tendencies towards social legislation and extension of governmental control over broader interests of the people.
5 class hours. Credit, 5.
Assistant Professor PARKER.

54. **I.** MODERN EUROPEAN HISTORY. — Juniors; seniors may elect. This course will take up the modern history of the principal countries of Europe, especially the great movements and revolutions that developed the nations up to the present generation.
3 class hours. Credit, 3.
Assistant Professor PARKER.

79. **II.** European History Since 1870. — For seniors; juniors may elect. In this course the Franco-Prussian War and the formation of the German Empire, the unification of Italy, the Third French Republic, European Expansion in the East, the Russo-Japanese War, and the origin, events and probable results of the War of 1914, will be studied in some detail. While a continuation of Course 54, this course will be complete in itself, and may be elected by those who have had no history training. Its aim is to provide the basis for an understanding of present-day conditions, and for an intelligent participation in world affairs.
3 class hours. Credit, 3.
Assistant Professor Parker.

Languages and Literature.

Professor Lewis, Professor Patterson, Professor Mackimmie, Professor ——, Professor Ashley, Assistant Professor Prince, Assistant Professor Julian, Mr. Rand, Miss Goessmann.

English.

Required Courses.

1. **I.** 2. **II.** 3. **III.** English. — Freshmen. Composition. Intended to teach straight thinking, sound structure, clear and correct expression. Lectures, recitations, theme writing and conferences.
3 class hours each term. Credit, 3 each term.
Professor Patterson, Assistant Professor Prince and Mr. Rand.

25. **I.** 26. **II.** 27. **III.** English. — Sophomores. A general reading course in English literature.
2 class hours each term. Credit, 2 each term.
Professor Lewis and Miss Goessmann.

Elective Courses in English Language and Literature.

50. **I.** English Poetry of the Romantic Period (1921–22). — This course alternates with course 53. For juniors; seniors may elect. A course in history, appreciation and understanding. Some of the writers studied are Gray, Goldsmith, Burns, Scott, Wordsworth, Coleridge, Byron, Keats and Shelley.
3 class hours. Credit, 3.
Professor Patterson.

51. **II.** English Poetry in the Nineteenth Century. — This course alternates with Course 54. For juniors; seniors may elect. In general, this course is like Course 50. Tennyson, Browning, Mrs. Browning, Arnold, Clough, the Rossettis, Morris and Swinburne are among the writers to be studied.
3 class hours. Credit, 3.
Professor Lewis.

57. **III.** English Poetry in the Nineteenth Century. — This course alternates with Course 58. For juniors; seniors may elect. As stated under Course 51.
3 class hours. Credit, 3.
Professor Lewis.

52. **III.** ENGLISH WRITERS FROM MILTON TO POPE. — For juniors; seniors may elect. A survey course that will emphasize the leading writers, literary currents and the thought of the period. Some of the writers studied are Milton, Dryden, Addison, Swift and Pope.
3 class hours. Credit, 3.
Professor PATTERSON.

53. **I.** ENGLISH PROSE OF THE ROMANTIC PERIOD. — For juniors; seniors may elect. A course in English prose paralleling Course 51. Some of the writers studied are Goldsmith, Coleridge, Lamb, DeQuincey and Hazlitt.
3 class hours. Credit, 3.
Professor PATTERSON.

54. **II.** ENGLISH PROSE IN THE NINETEENTH CENTURY (1921–22). — For juniors; seniors may elect. This course parallels Course 51. Among the writers considered will be Macaulay, Carlyle, Ruskin, Newman and Arnold.
3 class hours. Credit, 3.
Professor LEWIS.

58. **III.** ENGLISH PROSE IN THE NINETEENTH CENTURY (1921–22). — For juniors; seniors may elect. As stated under Course 54.
3 class hours. Credit, 3.
Professor LEWIS.

55. **II.** AMERICAN LITERATURE. — For juniors; seniors may elect. Intended to give a general survey of literature in America, especially in the nineteenth century, with an introduction to the work of the best known writers, and with especial attention to the relations between national life and history and national thought as expressed in literature. The usual authors — Irving, Cooper, Bryant, Poe, Longfellow, Emerson, Hawthorne, Whittier, Parkman, Lowell, Holmes, Whitman, Lanier — will be discussed.
3 class hours. Credit, 3.
Assistant Professor PRINCE.

56. **III.** AMERICAN LITERATURE. — For juniors; seniors may elect. As stated under Course 55.
3 class hours. Credit, 3.
Assistant Professor PRINCE.

Prerequisite, English 55.

60. **I.** THE LITERATURE OF RURAL LIFE. — For juniors; seniors may elect. A critical and appreciative study of writers, both in prose and poetry, who have interpreted nature from the viewpoint of the lover of country life, and those who have idealized agriculture, horticulture and other rural pursuits, together with those who have upheld as an ideal the development of a rural environment in cities.
3 class hours. Credit, 3
Miss GOESSMANN.

61. **II.** The Literature of Rural Life. — For juniors; seniors may elect. As stated under Course 60.
3 class hours. Credit, 3.
Miss Goessmann.
Prerequisite, English 60.

75. **III.** Prose Fiction. — The short story or the novel. For seniors; juniors may elect. Readings, reports and discussions. [Not given in 1920–21.]
3 class hours or library equivalents. Credit, 3.

79. **II.** The Drama. — For seniors; juniors may elect. A cursory survey of early English drama, its origin, forms and meaning, will be followed by a careful study of Shakespeare. Two of his plays will be analyzed in detail, and many others will be read and discussed.
3 class hours. Credit, 3.
Mr. Rand.

80. **III.** The Drama. — For seniors; juniors may elect. The course will trace the development of modern drama, especial attention being given to plays by Congreve, Goldsmith, Sheridan, Robertson, Jones, Pinero, Fitch, Shaw, Moody and Ibsen.
3 class hours. Credit, 3.
Mr. Rand.

Applied English — Rural Journalism.

The courses in rural journalism have two chief aims: first, to turn the student's attention toward matters of contemporary concern; second, to provide training for students who may wish to enter journalism (especially agricultural or industrial journalism or non-urban newspaper work), or who are preparing for the numerous other vocations in which acquaintance with newspaper practices and requirements is of value. All of the courses afford constant practice in writing. So far as conditions permit, instruction is largely individual.

50. **I.** Advanced Composition. — For juniors; seniors may elect. Advanced work in expository writing based upon specimens by contemporary authors and upon the personal experience of the student. Particular attention is given to organization, diction and style.
Credit, 3.
Mr. Rand.

51. **II.** Advanced Composition. — For juniors; seniors may elect. Work in journalistic and fictional narrative with supplementary reading.
Credit, 3.
Mr. Rand.

52. **III.** Advanced Composition. — For juniors; seniors may elect. The preparation of theses and similar manuscripts along such lines as the student may desire. Clearness and readability are the ends to be attained.
Credit, 3.
Mr. Rand.

53. **I.** 54. **II.** 55. **III.** NEWS-GATHERING AND NEWS-WRITING. — For juniors; seniors may elect. The foundation aims and conceptions of journalism; reporting. Central purpose, to develop ability to pick out essentials from inessentials, perceive elements of interest, and present facts which appeal to the reader. Courses 53, 54 and 55 are suited to students whose vocation may require the popular presentation of technical or other information; *e.g.*, extension workers, county agents, agricultural-school instructors, experiment-station editors, survey and other social-service workers, men engaged in sociological or economic investigations, landscape architects and civil and sanitary engineers.

6 laboratory hours or class equivalents, credit, 3.

77. **I.** 78. **II.** 79. **III.** EDITORIAL MATERIALS AND METHODS. — For seniors; juniors may elect. Readings, quizzes, reports and personal conferences; reading of daily papers and weekly reviews or rural-life periodicals; writing of editorial articles. Recommended to students who desire practice in discovering the significant aspects of matters of public attention and in effectively expressing comment thereon. [Not given in 1920–21.]

6 laboratory hours or class equivalents, credit, 3.

80. **I.** 81. **II.** 82. **III.** ADVANCED JOURNALISTIC PRACTICE. — Seniors. Preparation, editing and publication in a newspaper of a rural-life page. [Not given in 1920–21.]

8 or 10 laboratory hours, credits, 4 or 5.

PUBLIC SPEAKING.

Required Course.

1. **I, II** and **III.** PUBLIC SPEAKING. — Freshmen. Freshman public speaking is required in the first, second or third term, at the option of the instructor. The course is concerned with the actual problems which confront the man who would speak convincingly and persuasively. Much attention, therefore, is given to the preparation and delivery of extempore speeches.

1 class hour. Credit, 1.

Professor PATTERSON, Assistant Professor PRINCE and Mr. RAND.

Elective Courses.

50. **I.** ARGUMENTATION. — For juniors; seniors may elect. The course aims to present the fundamental principles of argumentation as applied to oral and written discourse, and intends to develop in the student power to handle argument convincingly and persuasively. Lectures, discussions of leading questions of the day, practice in brief-drawing and the writing of forensics. The course is recommended for those who desire to enter the intercollegiate debates.

3 class hours. Credit, 3.

Assistant Professor PRINCE.

Prerequisites, Public Speaking 1, 2 or 3.

51. **II.** Occasional Oratory. — For juniors; seniors may elect. The course involves a study of the elements of vocal expression and action; speeches on assigned subjects; prescribed reading; the preparation and delivery of several formal orations. Textbook, Shurter's "The Rhetoric of Oratory." The course is recommended for those who wish to enter the Flint contest.
3 class hours. Credit, 3.
Assistant Professor Prince.
Prerequisites, Public Speaking 1, 2 or 3.

French and Spanish.

Professor Mackimmie, ——.

The aim of the courses in French and Spanish is to give the student a practical knowledge of these languages for the purpose of wider reading and research, to introduce him to some of their treasures in art and science, and through the literature to acquaint him with the people. In the elementary courses as much time as possible is given to oral work, to develop a speaking, as well as a reading, knowledge of the tongue.

French.

Required Courses.

1. **I.** 2. **II.** 3. **III.** Elementary French. — Freshmen; open upon arrangement to other students. The essentials of grammar are rapidly taught and will be accompanied by as much reading as possible. This course is required of freshmen presenting German for entrance who do not continue that language and have not studied French.
3 class hours each term. Credit, 3 each term.
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4. **I.** 5. **II.** 6. **III.** Intermediate French. — Freshmen; open upon arrangement to other students. Training for rapid reading. The reading of a number of short stories, novels and plays; composition, reports on collateral reading from periodicals and scientific texts in the library.
3 class hours each term. Credit, 3 each term.
Professor Mackimmie.
Prerequisite, required of freshmen who present two years of French for entrance and do not take German.

Elective Courses.

25. **I.** Intermediate French. — For sophomores; open upon arrangement to other students. Training for rapid reading; the reading of a number of short stories, novels and plays; readings from periodicals and scientific texts in the library.
3 class hours. Credit, 3.
Professor Mackimmie.
Prerequisites, French 1, 2 and 3.

26. **II.** Intermediate French. — For sophomores; open upon arrangement to other students. As stated under Course 25.
3 class hours. Credit, 3.
Professor Mackimmie.
Prerequisite, French 25.

27. **III.** Intermediate French. — For sophomores; open upon arrangement to other students. As stated under Course 25.
3 class hours. Credit, 3.
Professor Mackimmie.

Prerequisite, French 26.

28. **I.** Advanced French. — For sophomores; open upon arrangement to other students. A reading course. Balzac's "Eugénie Grandet" and "Le Père Goriot," and other masterpieces of the nineteenth century; Brunetière's "Honoré de Balzac" and Harper's "Masters of French Literature;" readings in the library and written reports.
3 class hours. Credit, 3.

Prerequisites, French 4, 5 and 6.

29. **II.** Advanced French. — For sophomores; open upon arrangement to other students. As stated under Course 28.
3 class hours. Credit, 3.

Prerequisites, French 4, 5 and 6.

30. **III.** Advanced French. — For sophomores; open upon arrangement to other students. General view of the history of French literature; Kastner and Atkins' "History of French Literature." Representative works of the important periods will be studied in class. Outside reading will be required.
3 class hours. Credit, 3.

Prerequisites, French 25 and 26, or French 28 and 29.

50. **I.** Scientific French. — For juniors; seniors may elect. This course is planned to meet the requirements of the individual student, and aims to equip him with exact English equivalents for the French scientific terms in his particular science. Word lists of scientific terms will be required, and also weekly readings and reports from scientific works in the subject in which he is majoring. Several scientific readers will be read.
3 class hours. Credit, 3.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

51. **II.** Scientific French. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

52. **III.** Scientific French. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

75. **I.** French Literature. — For seniors; juniors may elect. The object of Courses 75, 76 and 77 is to give an introduction to recent movements in French literature. Course 75 will deal with the drama, and plays by Augier, A. Dumas *fils*, Delavigne and some contemporary dramatists will be read and studied.

3 class hours. Credit, 3.

Professor Mackimmie.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

76. **II.** French Literature. — For seniors; juniors may elect. This course deals with the novel. Works by Flaubert, the De Goncourts and Zola will be read. Written reports are required on outside reading.

3 class hours. Credit, 3.

Professor Mackimmie.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

77. **III.** French Literature. — For seniors; juniors may elect. Modern criticism. Sainte-Beuve, "Causeries du Lundi" (Harper) and works by Taine and Renan. Reference book, Lanson's "Histoire de la Littérature Française."

3 class hours. Credit, 3.

Professor Mackimmie.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

Spanish.

Elective Courses.

50. **I.** Elementary Spanish. — For juniors; seniors may elect. Open to other students upon arrangement. Grammar, with special drill in pronunciation; exercises in conversation and composition. Reading from a reader and selected short stories.

3 class hours. Credit, 3.

Professor Mackimmie.

51. **II.** Elementary Spanish. — For juniors; open to other students upon arrangement. As stated in Course 50.

3 class hours. Credit, 3.

Professor Mackimmie.

Prerequisite, Spanish 50.

52. **III.** Elementary Spanish. — For juniors; open to other students upon arrangement. As stated in Course 50.

3 class hours. Credit, 3.

Professor Mackimmie.

Prerequisite, Spanish 51.

75. **I.** Modern Spanish Authors. — Seniors. Reading from modern Spanish novel and drama. Translation of English into Spanish. Private reading.

3 class hours. Credit, 3.

Professor Mackimmie.

Prerequisite, Spanish 52.

76. **II.** MODERN SPANISH AUTHORS. — Seniors. As stated in Course 75.
3 class hours. Credit, 3.
Professor MACKIMMIE.

Prerequisite, Spanish 75.

77. **III.** MODERN SPANISH AUTHORS. — Seniors. As stated in Course 75.
3 class hours. Credit, 3.
Professor MACKIMMIE.

Prerequisite, Spanish 76.

German and Music.

Professor ASHLEY, Assistant Professor JULIAN.

GERMAN.

The courses in German are intended to give the student a reading knowledge of the language and to introduce to him some of the masterpieces of German literature. To the student interested in pursuing advanced reading in scientific German, opportunity is given to do corollary reading in his major subject, in collaboration with the head of that department.

Required Courses.

1. **I.** 2. **II.** 3. **III.** ELEMENTARY GERMAN. — Freshmen; open upon arrangement to other students. Grammar, composition and reading. Especial attention is given to oral work in German and to translation of English into German. Required of those presenting French for entrance who do not continue that language and have not studied German.
3 class hours each term. Credit, 3 each term.
Professors ASHLEY and JULIAN.

4. **I.** 5. **II.** 6. **III.** INTERMEDIATE GERMAN. — Freshmen; open upon arrangement to other students. Selected works of Schiller, Heine and Goethe. Grammar review and advanced prose composition.
3 class hours each term. Credit, 3 each term.
Professor ASHLEY.

Prerequisite, required of freshmen who present two years of German for entrance and do not take French.

Elective Courses.

25. **I.** INTERMEDIATE GERMAN. — For sophomores; open upon arrangement to other students. Reading of such works as Sudermann's "Frau Sorge," "Wilhelm Tell," "Die Journalisten," etc. Grammar review.
3 class hours. Credit, 3.
Assistant Professor JULIAN.

Prerequisites, German 1, 2 and 3.

26. **II.** INTERMEDIATE GERMAN. — For sophomores; open upon arrangement to other students. As stated under Course 25.
3 class hours. Credit, 3.
Assistant Professor JULIAN.

Prerequisite, German 25.

27. **III.** INTERMEDIATE GERMAN. — For sophomores; open upon arrangement to other students. As stated under Course 25.
3 class hours. Credit, 3.
Assistant Professor JULIAN.

Prerequisite, German 26.

28. **I.** ADVANCED GERMAN. — For sophomores; open upon arrangement to other students. Reading and studying of Goethe's most important literary productions.
3 class hours. Credit, 3.
Professor ASHLEY.

Prerequisites, German 4, 5 and 6.

29. **II.** ADVANCED GERMAN. — For sophomores; open upon arrangement to other students. Development of the German novel; rapid reading of great novelists.
3 class hours. Credit, 3.
Professor ASHLEY.

Prerequisite, German 28.

30. **III.** ADVANCED GERMAN. — For sophomores; open upon arrangement to other students. As stated under Course 29.
3 class hours. Credit, 3.
Professor ASHLEY.

Prerequisite, German 29.

50. **I.** SCIENTIFIC GERMAN. — For juniors; seniors may elect. Reading in German of modern magazine articles and works of a scientific nature. Different work assigned according to needs of individual students.
3 class hours. Credit, 3.
Professor ASHLEY.

Prerequisites, German 4, 5 and 6, or German 25, 26 and 27.

51. **II.** SCIENTIFIC GERMAN. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.
Professor ASHLEY.

Prerequisite, German 50.

52. **III.** SCIENTIFIC GERMAN. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.
Professor ASHLEY.

Prerequisite, German 51.

75. **I.** GERMAN LITERATURE. — Seniors. Advanced language and literary study. Conducted entirely in German. Lectures on German literature and history; life, customs and travel in Germany. Collateral readings, including masterpieces of different epochs, such as "Niebelungenlied," Goethe's "Faust" and one modern typical drama.
3 class hours. Credit, 3.
Professor ASHLEY.

Prerequisites, German 28, 29 and 30.

76. **II.** German Literature. — Seniors. As stated under Course 75.
3 class hours. Credit, 3.
Professor Ashley.
Prerequisite, German 75.

77. **III.** German Literature. — Seniors. As stated under Course 75.
3 class hours. Credit, 3.
Professor Ashley.
Prerequisite, German 76.

78. **I.** Conversation and Composition. — For seniors; juniors may elect. Translating connected English into German. Reproducing outside readings in German orally in class.
1 class hour. Credit, 1.
Professor Ashley.
Prerequisites, German 4, 5 and 6, or German 25, 26 and 27.

79. **II.** Conversation and Composition. — For seniors; juniors may elect. As stated under Course 78.
1 class hour. Credit, 1.
Professor Ashley.
Prerequisite, German 78.

80. **III.** Conversation and Composition. — For seniors; juniors may elect. As stated under Course 78.
1 class hour. Credit, 1.
Professor Ashley.
Prerequisite, German 79.

Music.

Elective Courses.

50. **I.** History and Interpretation of Music. — For juniors; seniors may elect. History of music among the ancients; medieval and secular music; epoch of vocal counterpoint; development of monophony opera and oratorio; life and works of the greatest representatives of the classical school, — Bach, Händel, Haydn, Gluck and Mozart.
1 class hour. Credit, 1.
Professor Ashley.

51. **II.** History and Interpretation of Music. — For juniors; seniors may elect. A continuation of Course 50. The Romantic school; Beethoven, Schubert, Weber, Mendelssohn, Schumann, Chopin, Berlioz and Liszt; Wagner and the opera.
1 class hour. Credit, 1.
Professor Ashley.

52. **III.** History and Interpretation of Music. — For juniors; seniors may elect. The Modern school and Modern composers.
1 class hour. Credit, 1.
Professor Ashley.

DIVISION OF RURAL SOCIAL SCIENCE.

President BUTTERFIELD.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Agricultural Economics.

Professor CANCE, Mr. SAWTELLE.

Instruction in agricultural economics is designed to show that the agricultural industry justifies its existence chiefly as a supplier of food and raw textile materials for human consumption; that agricultural success is measured by production of values rather than by production of volume of agricultural products; that the goal of the farmer is the largest net profit over a long-time period; that agricultural production includes all processes from purchase of seed and fertilizer and preparation of seedbed until the product reaches the consumer, including collection, transportation, storage, financing, packing, handling and selling; that a knowledge of the business of agriculture and agricultural commerce is to-day more necessary than a knowledge of agricultural technique.

The work of this department is conducted by means of lectures, readings and research in both library and field. A catalogue, now containing some 12,000 cards, covering the various phases of agricultural economics, is maintained. The department is also supplied with a large collection of maps, charts and statistical reports on the prices and supply of agricultural products. A goodly number of regular reports of the Bureau of Markets and other divisions of the United States Department of Agriculture are on file in the office of the department, and available for the use of students. Two series of bound volumes of bulletins are kept in the department offices, with duplicate series in the college library; one series already contains 12 volumes on "Co-operation in Agriculture," and the other, 15 volumes on "Marketing of Farm Products."

Required Course.

26. **II.** AGRICULTURAL INDUSTRY AND RESOURCES. — Sophomores. A descriptive course dealing with agriculture as an industry and its relation to physiography, movement of population, supply of labor, commercial development, transportation, public authority and consumers' demand. The principal agricultural resources of the United States will be studied with reference to commercial importance, geographical distribution, present condition and means of increasing the value of the product and cheapening cost of production. Lectures, assigned readings, class topics and discussions.
5 class hours. Credit, 5.
Professor CANCE.

Elective Courses.

50. **I.** ELEMENTS OF AGRICULTURAL ECONOMICS. — For juniors; seniors may elect. This course is designed to accompany or follow the course in elements of economics. It deals with the economic principles underlying the welfare

and prosperity of the farmer and those institutions upon which his economic success depends; the economic elements in the production and distribution of agricultural wealth; means of exchange; principles of rural credit; problems of land tenure and land values; taxation of farm property; and the maintenance of the economic status of the farmer. Lectures, text, readings, topics and field work.
5 class hours. Credit, 5.
Professor Cance.

51. **III.** Historical and Comparative Agriculture. — For juniors; seniors may elect. A general survey of agriculture, ancient and modern; feudal and early English husbandry; the later development of English agriculture; the course of agriculture in the United States, with special emphasis on the development of agriculture in New England. An attempt will be made to measure the influence of times, peoples and countries in producing different systems of agriculture, and to ascertain the causes now working to effect agricultural changes. Lectures, readings and library work. Students in education and rural journalism should find this course helpful.
5 class hours. Credit, 5.
Mr. Sawtelle.

52. **II.** Co-operation in Agriculture. — For juniors; seniors may elect. The course treats of the history, principles and business relations of agricultural co-operation. (1) A survey of the development, methods and economic results of farmers' organizations and great co-operative movements; (2) the business organization of agriculture abroad, and the present aspects and tendencies in the United States; (3) the principles underlying successful co-operative endeavor among farmers, practical working plans for co-operative associations, with particular reference to credit and purchase and the marketing of perishable products. Lectures, text, assigned readings and practical exercises.
5 class hours. Credit, 5.
Professor Cance and Mr. Sawtelle.

53. **III.** The Agricultural Market.—For juniors; seniors and graduate students may elect. A study of the forces and conditions which determine the prices of farm products and the mechanism, methods and problems concerned with transporting, storing and distributing them. Supply and demand, course of prices, terminal facilities, the middleman system, speculation in agricultural products, protective legislation, the retail market and direct sales are taken up. The characteristics and possibilities of the New England market are given special attention. Lectures, readings, assigned studies and field work.
5 class hours. Credit, 5.
Professor Cance.

76. **II.** Transportation of Agricultural Products. — For seniors and graduate students; juniors may elect. This course deals with the development of highway, waterway and railway transportation and its relation to the agricultural development of the country; the principles governing the

operation and control of transportation agencies; present-day problems relating to the shipment of farm products, rates, facilities and services; methods of reducing wastes in transportation; the economics of the good roads movement and of motor transportation. Lectures, text and field work.
5 class hours. Credit, 5.
Professor Cance and Mr. Sawtelle.

77. **I.** Problems in Agricultural Economics. — For seniors and graduate students; juniors may elect. An advanced course for students desirous of studying more intensively some of the economic problems affecting the farmer. Some of these are: land problems, — land tenure, size of farms, causes affecting land values, private property in land, taxation of farm property; special problems, — cost of producing farm products, farm labor in New England, immigration, agricultural credit. Opportunity will be given, if practicable, for field work, and students will be encouraged to pursue lines of individual interest.
5 class hours. Credit, 5.
Professor Cance.

78. **III.** Agricultural Credit Facilities. — For seniors and juniors. Lectures, discussions and assigned readings on credit needs of farmers; the legitimate use of credit in the acquisition of land, and the production, storage and marketing of agricultural products; the development of national and State rural credit institutions and laws; the powers and methods of operation of credit institutions with reference to the supply of credit for agricultural purposes; the methods by which the individual may increase his credit standing and borrowing power; ways in which the present credit facilities may be increased.
3 class hours. Credit, 3.
Mr. Sawtelle.

79. **I.** Agricultural Statistics. — For seniors, juniors and graduate students. This course deals with the nature and sources of agricultural statistics, the methods of obtaining numerical facts, of analyzing and drawing conclusions from statistical data, and the methods of presenting in a true and forceful manner the statistical facts of the agricultural industry. Opportunity is given in the laboratory for practice in the use of statistical methods and processes, and to acquire experience in dealing with practical statistical problems. The application of statistics and statistical methods in the fields of agricultural economics, extension work, education, journalism and the business matters connected with farm operation is emphasized.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Mr. Sawtelle.

80. **I.** Seminar. — For seniors and graduate students. Research in agricultural economics and history; problems of New England agriculture. Library work and reports. If desirable some other topic may be substituted. Hours to be arranged.
1 2-hour conference period, credit, 1 or 2.
The Department.

81. **II.** Seminar. — For seniors and graduate students. As stated in Course 80.

1 2-hour conference period, credit, 1 or 2.
The Department.

82. **III.** Seminar. — For seniors and graduate students. As stated in Course 80.

1 2-hour conference period, credit, 1 or 2.
The Department.

Agricultural Education.

Professor Hart, Professor Welles, Mr. Heald,[1] Miss Hamlin.

The plan of the teacher-training courses is as follows: —

(*a*) A Two-year Teacher-training Course. — Designed for mature persons of approved farm experience and educational advancement, who declare an intention to prepare for teaching in vocational agricultural schools or departments in Massachusetts. This course leads to a certificate of credit from the Massachusetts Department of Education. This certificate places the holder on the preferred list of candidates for teaching in vocational agricultural schools and departments. The course is under the joint guidance of the agent of the Massachusetts Department of Education and the Department of Agricultural Education. Each student's work is so planned that he may pursue with thoroughness the subjects in which his previous preparation may have been deficient. His program is planned with reference to his main objective, whether it is teaching agriculture or an allied subject.

(*b*) A Four-year College Course. — Entered under the usual entrance conditions. This leads to the degree of bachelor of science and to a teacher's certificate from the Massachusetts Department of Education. This certificate authorizes the holder to teach in a State-aided high school. The program for obtaining a teacher's certificate is planned under the supervision of the Department of Agricultural Education. The course also leads to a certificate of credit from the Massachusetts Department of Education, which places the holder on the preferred list of candidates for teaching in vocational agricultural schools and departments. Students are guided in the choice of courses for the certificate of credit by the Department's agent at the college. The program is carried out in accordance with a co-operative agreement between the Massachusetts Department of Education and the Massachusetts Agricultural College.

(*c*) Professional Improvement Course. — Designed for teachers in service who seek improvement. Programs are planned strictly on the basis of individual needs, under the guidance of the agent of the Massachusetts Department of Education at the Massachusetts Agricultural College. In the prosecution of this program a student may enter courses given in the Summer School, in the Winter School, and in the four-year curriculum under the limitations of the schedule and his own qualifications to do the work. When the call seems to justify it, and subject to administrative and equipment limitations, special classes will be organized for carrying out this program. In the case of qualified persons, some of this work may be done in the Graduate School.

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[1] Representing the Massachusetts Department of Education in the administration of vocational education acts.

(*d*) COURSES FOR PARTLY PREPARED CANDIDATES. — Designed for supplementing the training of candidates whose qualifications are deficient in one or more particulars for teaching in vocational agricultural schools or departments. These programs may coincide in some cases with those in (*a*) or (*c*). They are planned under the guidance of the agent of the Massachusetts Department of Education in accordance with a co-operative agreement between the Department and the Massachusetts Agricultural College.

(*e*) PRESCRIBED COURSES. — Some study in the Department of Agricultural Education is required in all the foregoing programs. A minimum of 16 credit hours out of a total of 243 is required in those programs leading to a bachelor of science degree, to a teacher's certificate, or to a certificate of credit.

The equipment includes a combination classroom and laboratory for use in teaching agriculture in secondary schools. It is equipped with filing cases for records; cases for books and apparatus; a display-board for pictures, maps, charts, etc.; individual study desks; tables for supervised study; demonstration table supplied with sink, hot and cold water and gas, etc. The department office is equipped with books and pamphlets on agricultural education, properly catalogued.

25. **III.** AGRICULTURAL OPPORTUNITIES FOR WOMEN. — Sophomores. A course designed to show the woman who is interested in agriculture what opportunities there are for her in that field, and how she may best take advantage of them. The types of agricultural work for which women are best adapted will be discussed. A study will be made of some of the special problems which confront the woman farmer, and of her best ways of solving them. 2 class hours. Credit, 2.

Miss HAMLIN.

Elective Courses.

50. **I.** EDUCATIONAL PSYCHOLOGY. — For juniors; sophomores and seniors may elect. Work planned primarily for candidates for teaching. Consists of a study of the mental growth and development, and some correlations of the mind and nervous system.

5 periods, credit, 5.
Professor HART.

51. **I, II** and **III.** PRINCIPLES AND METHODS OF TEACHING. — For juniors; seniors may elect. A study of the laws of learning, exhaustive inquiry into the meaning of interest, apperception, memory-images, judging and reasoning, and their applications in teaching processes, class management and organization of lesson plans.

5 periods, credit, 5.
Professor WELLES.

52. **III.** HISTORY AND PHILOSOPHY OF EDUCATION. — For juniors; seniors may elect. A study of educational history in modern times, educational movements in the United States and their bearing on national aims and ideals, with special emphasis on education for a democracy.

5 periods, credit, 5.
Professor WELLES.

75. **I.** Organization and Supervision of Secondary Education. — For seniors; juniors may elect. School systems, courses of study, training of teachers, financial support, recent tendencies and policies in secondary schools.

3 periods, credit, 3.
Professor Welles.

76. **I, II** and **III.** Special Methods in Vocational Agriculture. — For seniors; juniors and others qualified may elect. Consists of the outlining of lessons, outlining of projects for agricultural teaching, and applications of the principles of vocational education as embodied in the Smith-Hughes Act, and other legislation relative to agricultural education.

3 periods, credit, 3.
Professor Welles.

77. **III.** County Agent Work. — For seniors. Work on special agricultural problems by individual students; preparation and presentation of a number of theses, using charts and other apparatus. Major advisers will be responsible for accuracy of subject-matter; the Department of Agricultural Education will be responsible for preparation and presentation.

5 periods, credit, 5.
Professor Hart.

80. **I, II, III** and **IV.** Teacher-training Course. — For seniors and graduate students. Work will consist of supervised apprentice teaching accompanied by the arranging of subject-matter for lessons, the outlining of projects, and professional study. The number of credits will depend upon the number, character and length of teaching exercises and conferences. The work will be carried on in co-operation with the Massachusetts Department of Education.

Credits, 1 to 5.
Professor Welles.

90. **III.** Genetic Psychology. — Primarily for seniors; juniors may elect. This course involves a study of the physical and mental growth and development of the individual from birth to maturity; a comparative study of the physiological and mental ages of children; and mental tests.

3 class hours. Credit, 3.
Professor Hart.

91. **I.** Rural Education. — Primarily for graduates; seniors may elect. A study of the development of the rural school; its organization and administration; its function for the community and for the individual; its place in the State system; some local surveys.

3 class hours. Credit, 3.
Professor Hart.

Rural Sociology.

Professor PHELAN, President BUTTERFIELD, Professor SIMS, Professor HART, Mr. NOVITSKY.[1]

The courses in rural sociology are designed for two purposes: first, to give students an appreciation of the general problems of country life; second, to afford a definite training for students who wish to take up some specific form of social service. In the last ten years rural sociology has been introduced as a subject into more than 50 per cent of the agricultural schools and colleges. There is a good demand for teachers, and an increasing opportunity in other directions in this subject. The courses afford the student an opportunity to pursue graduate as well as undergraduate work. The library of the college is unusually well equipped with rural sociological material.

Required Course.

27. **III.** ELEMENTS OF RURAL SOCIOLOGY. — Sophomores. A broad survey of the field of rural sociology, including such topics as the origin of rural sociology, its methods and problems; relation of sociological to the scientific and technical aspects of agricultural problems; the development of the rural community in New England and the west, religious, educational and social ideals of rural people; characteristics and influence of the rural environment, the movement of the rural population, the effects of immigration; rural institutions, the school, the church, local government, effects of modern conditions of life on rural institutions; rural organization; problems of progress, an analysis of the needs of rural life in its further development. Lectures, readings and essays on assigned topics.

3 class hours. Credit, 3.

Professor SIMS.

Elective Courses.

50. **I.** SOCIAL CONDITION OF RURAL PEOPLE. — For juniors; seniors may elect. A. The rural status: composition of the rural population, nature, extent and causes of diseases and accidents, health agencies of control; extent and causes of rural delinquency and dependency, conditions of temperance, of sexual morality and family integrity; child labor, women's work and position; standard of living, size of family; cultural ideals; community consciousness and activity; standards of business conduct and of political ethics.

B. Rural social psychology: characteristics of the rural mind, character of hereditary and environmental influence; nature and effect of face-to-face groups; fashion, conventionality, custom, character of discussion and of public opinion.

3 class hours. Credit, 3.

Professor SIMS.

51. **II.** RURAL GOVERNMENT. — For juniors; seniors may elect. A general survey of the development of rural government in the United States, origin of the New England town, its influence upon the west, advantages, development of efficiency, county government, the influence of the farmer in legislation, good roads movement, credit facilities, taxation, boards of agri-

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[1] On leave of absence.

culture, agricultural colleges and experiment stations in relation to rural welfare; national government; a general survey of political organizations and movements among farmers in the United States and foreign countries and their influence in shaping legislation; relation of the Department of Agriculture, postal system, the various national commissions and agencies to rural welfare. Lectures, readings, written exercises on assigned topics.
3 class hours. Credit, 3.
Professor SIMS.

52. **III.** RURAL ORGANIZATION. — For juniors; seniors may elect. A study of the organized agencies by which rural communities carry on their various forms of associated life, particularly a study of the ways by which the domestic, economic, cultural, religious and political institutions contribute to rural betterment; principles underlying leadership, qualifications of the paid leader and the lay leader; the field of rural social service, national, State and local, preparation and opportunity for service; rural community building, a study of organized ways and means by which aid is given local communities. The method, scope and history of local, State and national associations formed about some farm product, their influence in forming class consciousness and in shaping agrarian legislation; need of federation. Lectures, readings and essays on assigned topics.
3 class hours. Credit, 3.
President BUTTERFIELD.

76. **I.** FIELD WORK IN RURAL SOCIOLOGY. — For seniors; juniors may elect. This course is designed to meet the needs of students who wish to do some constructive work in rural social service while still in college. The work will be carried on in co-operation with the various college agencies engaged in rural service. Any project for which credit in this course is to be asked must first have the approval of the head of the department.
From 2 to 6 laboratory hours, credits, 1 to 3.
Professor PHELAN.
Prerequisites, Rural Sociology 27 and 52.

77. **II.** RURAL SOCIAL SURVEYS. — For seniors; juniors may elect. A careful study of the theory and function of statistics, the limitations and difficulties in the use of statistics, the interpretation of statistical data, various methods of graphic representation; a study of surveys, kinds and use, method of gaining information, the basis for conclusions, value of information gained. Text and lectures.
3 class hours. Credit, 3.
Professor SIMS.

78. **II.** RURAL AND BUSINESS LAW. — For seniors; juniors may elect. The work of this course will cover such points as land, titles, public roads, rights incident to ownership of live stock, contracts, commercial paper and distinctions between personal and real property. Text, written exercises, lectures and class discussions.
5 class hours. Credit, 5.
Professor HART.

79. **I.** Seminar. — Enrollment is limited to students who have had at least three courses in rural sociology, and to students majoring in the subject.
Credit, 1 to 3.
Professor Phelan.

80. **II.** Seminar. — Enrollment is limited to students who have had at least three courses in rural sociology, and to students majoring in the subject.
Credit, 1 to 3.
Professor Phelan.

81. **III.** Seminar. — Enrollment is limited to students who have had at least three courses in rural sociology, and to students majoring in the subject.
Credit, 1 to 3.
Professor Phelan.

Rural Home Life.

Miss Skinner, Mrs. Strahan.

The Department of Rural Home Life offers elective courses for students majoring in other departments of the college. Fundamentally this training is such as will help young women to be better prepared to adjust themselves readily to their environment in the home and in the community, and to help them realize their responsibility as good homemakers and as good citizens. In addition to the elective courses indicated, courses in foods, clothing, business of the household and home care of the sick are offered to students in the two-year course in practical agriculture, and to students in the Ten Weeks' Winter School; and courses for teachers are offered in connection with the work of the Summer School.

The food laboratory, located in the entomology building, is fitted with individual desks (cabinet form) to hold utensils and materials for each student. Each table is equipped with gas stoves. A storage cabinet is provided with bins for supplies and cupboard space for large utensils and illustrative material. This room is well lighted and pleasant. The clothing laboratory is attractively located in French Hall. The equipment consists of sewing machines, cabinets, work tables, cutting tables, electric irons, dress forms and a collection of materials illustrating the production of textiles for clothing and household use.

Required Courses.

2. **II.** Introduction to Home Economics. — Freshmen women. A series of lectures concerned with the history and evolution of the home; social customs and their value in family relationships; healthful and suitable care of the wardrobe; principles of nutrition as applied to the student's life; the student's budget, and the keeping of personal accounts.
2 class hours. Credit, 2.
Miss Skinner.

3. **III.** Introduction to Food Study. — Freshmen women. A study of the principles of the selection and preparation of food. Introductory to other food courses that are to follow. Spring term.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Miss Skinner.

Elective Courses.

25. **I.** 26. **II.** 27. **III.** TEXTILES AND CLOTHING. — Sophomores. The selection and purchase of suitable materials, their character, cost and durability. Appropriateness and simplicity in dress. There will be practical work in hand and machine sewing, drafting and designing of patterns, the care and repair of clothing.
1 lecture. 2 2-hour laboratory periods, credit, 3.
MRS. STRAHAN.

50. **I.** 51. **II.** 52. **III.** FOODS AND COOKERY. — Juniors. A course to establish a fundamental knowledge of foods. The lectures deal with a discussion of the comparative composition, cost and economic value of foodstuffs; their sources, production and manufacture. Laboratory practice in applying scientific principles to the selection and preparation of typical foods.
1 class hour. 2 2-hour laboratory periods, credit, 3.
MISS SKINNER.

75. **I.** 76. **II.** HOUSEHOLD MANAGEMENT. — Seniors. This course deals with the application of the principles of scientific management to the household, and the elements of successful home making. It includes a study of the family income, cost of living, household accounts, the budget and its apportionment. Consideration will also be given to the responsibility of the woman to her family and the community in establishing right standard of living.
2 class hours. Credit, 2.
MISS SKINNER.

78. **III.** HOME NURSING. — Seniors. This course includes a study of the care of the family health; simple diseases and their prevention; the care of young children and invalids; first aid to the injured.
2 class hours. Credit, 2.
MISS SKINNER.

GENERAL DEPARTMENTS.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Military Science and Tactics.

Lieutenant-Colonel R. W. Walker, Cavalry, U. S. A.; Major F. E. Shnyder, Cavalry, U. S. A.; Technical Sergeant John J. Lee, U. S. A., retired; First Sergeant William A. Brown, Cavalry, U. S. A.; Stable Sergeant Walter D. Collier, Cavalry, U. S. A., and a detachment of enlisted men of the United States Army.

Under act of Congress (July 2, 1862) military instruction under a regular army officer was required in this college of all able-bodied male students. Under act of Congress June 3, 1916, as amended by act of Congress Sept. 8, 1916, there was established at this college in April, 1917, an infantry unit of the Reserve Officers' Training Corps. Following the World War and an act of Congress (July 9, 1918) the Reserve Officers' Training Corps is in operation under the regulation of the War Department, administered by the president of the college and the professor of military science and tactics.

The primary object of the R. O. T. C. is to provide systematic military training at civil educational institutions, for the purpose of qualifying selected students of such institutions as reserve officers in the military forces of the United States. It is intended to attain this object during the time the students are pursuing their general or professional studies, with the least practicable interference with their civil careers, by employing methods designed to fit men physically, mentally and morally for pursuits of peace as well as war.

All candidates for a degree in a four-year course must take for two years three hours a week of military training.

Students in their junior and senior years, who are approved by the president and the professor of military science and tactics, may take the advanced course if they so elect. The advanced course consists of five hours per week and a summer camp of about six weeks during the summer vacation, between the junior and senior years. Students taking this course are paid by the Federal government at a rate to be fixed by the Secretary of War, not to exceed the value of the army ration. The rate now fixed is 53 cents per day, which amounts to about $190 per year. Students graduating in the advanced course are eligible for commissions in the Officers' Reserve Corps, *but are not required to accept such commissions if offered.*

The required uniform is of olive drab woolen cloth, and is furnished for the use of the students by the Federal government without cost. It is worn by all cadets when on military duty, and may be worn at other times. New uniforms are furnished each year.

Beginning with the fall term, 1920–21, there was established a cavalry unit of the R. O. T. C. This work should fit in well with the Departments of Animal Husbandry and Veterinary Science, besides affording students a recreational and physical exercise not usually found at educational institutions.

Required Courses.

1. **I.** Tactics. — Freshmen. Theoretical instruction through the school of the trooper and squad. Lectures on military subjects.
1 class hour. Credit, 1.
Lieutenant-Colonel Walker.

2. **II.** Tactics. — Freshmen. Theory of small-arms firing, minor tactics, guard duty, personal hygiene and first-aid.
1 class hour. Credit, 1.
Lieutenant-Colonel Walker.

3. **III.** Tactics. — Freshmen. Theoretical instruction in cavalry drill regulations, dismounted. Lectures on military subjects.
1 class hour. Credit, 1.
Lieutenant-Colonel Walker.

4. **I.** Drill. — Freshmen. Practical instruction in cavalry drill regulations, dismounted, schools of the trooper, squad and platoon, close and extended order.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeants Lee and Collier.

5. **II.** Drill. — Freshmen. Physical drill, position and aiming drills, gallery practice.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeants Lee and Collier.

6. **III.** Drill. — Freshmen. Practical instruction in cavalry drill, dismounted, marching, ceremonies and guard.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeants Lee and Collier.

25. **I.** Tactics. — Sophomores. Cavalry drill regulations, elementary topography and map reading. Lectures on military subjects.
1 class hour. Credit, 1.
Lieutenant-Colonel Walker.

26. **II.** Tactics. — Sophomores. Theory of small arms firing and musketry, minor tactics, signaling.
1 class hour. Credit, 1.
Lieutenant-Colonel Walker.

27. **III.** Tactics. — Sophomores. Theoretical instruction in cavalry drill regulations. Lectures on military subjects.
1 class hour. Credit, 1.
Lieutenant-Colonel Walker.

28. **I.** Drill. — Sophomores. Practical instruction in cavalry drill regulations, schools of the trooper, platoon and troop, close and extended order, mounted and dismounted.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeant Brown.

29. **II.** Drill. — Sophomores. Physical drill, position and aiming drills, gallery practice, saber manual and exercises, pistol exercises.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeant Brown.

30. **III.** Drill. — Sophomores. Practical instruction in cavalry drill, marching, ceremonies, guard, range practice, rifle and pistol.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeant Brown.

Elective Courses.

50. **I.** Military Science. — Juniors. Topography, minor tactics, lectures, cavalry drill regulations, equitation.
3 class hours. Credit, 3.
Lieutenant-Colonel Walker and Sergeant Brown.

51. **II.** Military Science. — Juniors. Law, common and military, minor tactics, lectures on military subjects, equitation. Automatic rifle and machine guns.
3 class hours. Credit, 3.
Lieutenant-Colonel Walker and Sergeant Brown.

52. **III.** Military Science. — Juniors. Minor tactics, field engineering and equitation.
3 class hours. Credit, 3.
Lieutenant-Colonel Walker and Sergeant Brown.

53. **I.** Drill. — Juniors. Duties consistent with rank as cadet officers or noncommissioned officers in connection with practical work laid down for the unit.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeants Lee, Brown and Collier.

54. **II.** Drill. — Juniors. As stated under Course 53.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeants Lee, Brown and Collier.

55. **III.** Drill. — Juniors. As stated under Course 53, automatic rifles, machine guns, dismounted pistol practice.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeants Lee, Brown and Collier.

75. **I.** Military Science. — Seniors. Advanced topography and the solution of map problems. Minor tactics, troop administration, hippology, cavalry drill regulations, equitation.
3 class hours. Credit, 3.
Lieutenant-Colonel Walker and Sergeant Brown.

76. **II.** Military Science. — Seniors. Military law, military policy of the United States, minor tactics. Lectures on military subjects, equitation.
3 class hours. Credit, 3.
Lieutenant-Colonel Walker and Sergeant Brown.

77. **III.** Military Science. — Seniors. Tactical rides, military history of the United States, field engineering, equitation.
3 class hours. Credit, 3.
Lieutenant-Colonel Walker and Sergeant Brown.

78. **I.** Drill. — Seniors. As stated under Course 53.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeants Lee, Brown and Collier.

79. **II.** Drill. — Seniors. As stated under Course 53.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeants Lee, Brown and Collier.

80. **III.** Drill. — Seniors. As stated under Course 53. Automatic rifle, machine guns, mounted pistol practice.
2 laboratory hours. Credit, 1.
Lieutenant-Colonel Walker and Sergeants Lee, Brown and Collier.

Physical Education and Hygiene.

Professor Hicks, Assistant Professor Gore, Mrs. Hicks, Mr. Grayson, Mr. Jakeman.

The purpose of the courses offered by this department is to provide active exercise and to instruct every student how to care for his health and maintain his physical condition while carrying on his college course.

The equipment consists of the Alumni Athletic Field, which has room for two football fields, a quarter-mile cinder track with a 220 straightaway, and the baseball diamond; and also the old field for class football and baseball, two tennis courts, and the drill hall floor for basket-ball. For several years the drill hall floor was used for class work in gymnastics, but its condition has become so bad that this has been discontinued. During the winter months a hockey rink is provided on the college pond.

[All classified undergraduate male students are given a physical examination upon entering.]

Men.

Required Courses.

1. **I.** Hygiene. — Freshmen. Lectures on personal hygiene.
1 class hour. Credit, 1.
Professor Hicks.

2. **I.** Recreation. — Freshmen. Outdoor games.
1 laboratory hour. Credit, third term.
Mr. Grayson.

3. **III.** Recreation. — Freshmen. Outdoor games.
1 laboratory hour. Credit for Nos. 2 and 3, 1.
Mr. Grayson.

25. **I.** Recreation. — Sophomores. Outdoor games.
1 laboratory hour. Credit, third term.
Mr. Jakeman.

26. **III.** Recreation. — Sophomores. Outdoor games.
1 laboratory hour. Credit for Nos. 25 and 26, 1
Mr. Jakeman.

Elective Course.

77. **III.** Training Course. — Seniors. Election by permission only. History of physical education and supervision of athletics.
1 class hour. Credit, 1.
Professor Hicks.

WOMEN.

Required Courses.

4. **I.** Recreation. — Freshmen. Outdoor games.
3 laboratory hours. Credit, 1.
Mrs. Hicks.

5. **II.** Gymnastics. — Freshmen. Dancing, Swedish games, etc.
3 laboratory hours. Credit, 1.
Mrs. Hicks.

6. **III.** Recreation. — Freshmen. Outdoor games.
3 laboratory hours. Credit, 1.
Mrs. Hicks.

27. **I.** Recreation. — Sophomores. Outdoor games.
3 laboratory hours. Credit, 1.
Mrs. Hicks.

28. **II.** Gymnastics. — Sophomores. Dancing, Swedish games, etc.
3 laboratory hours. Credit, 1.
Mrs. Hicks.

29. **III.** Recreation. — Sophomores. Outdoor games.
3 laboratory hours. Credit, 1.
Mrs. Hicks.

Elective Courses.

50. **II.** Gymnastics. — Juniors. Dancing, Swedish games, etc.
3 laboratory hours. Credit, 1.
Mrs. Hicks.

76. **II.** Gymnastics. — Seniors. Dancing, Swedish games, etc.
3 laboratory hours. Credit, 1.
Mrs. Hicks.

THE LIBRARY.

The library — stack room, reading room and office — occupies the entire Chapel building. It contains about 65,000 catalogued volumes, several thousand volumes not catalogued, and a large number of bulletins, farm papers and other material, which is being put into good working order as fast as possible. Works on agriculture, horticulture, botany, entomology and the various sciences predominate, but literature, history and sociology are well represented and receive due attention. The reading room provides a good variety of popular and technical periodical literature, encyclopedias and general reference books.

The library is being reclassified and recatalogued in order to make the splendid material accessible and of the greatest working value. Every effort is being made toward developing the college library into a vital intellectual center, of equal value to every student, teacher and teaching department on the college campus. Consequently only the most cordial relations are cherished, and the fewest and most imperative rules concerning the circulation of books and deportment are enforced. An agricultural reference library is maintained in Stockbridge Hall, and department libraries are also maintained in some of the other buildings on the campus.

Occasional lectures are given to regular and short-course students in order to make the best use of the library equipment. Emphasis is laid upon the card catalogue, periodical indexes, bibliographies and guides, and the large collections of United States Department of Agriculture and experiment station literature.

Library hours are from 8 A.M. to 9.30 P.M. every week day, and from 9 A.M. to 1.30 P.M. on Sundays in term time. Shorter hours prevail during vacation.

THE GRADUATE SCHOOL

THE GRADUATE SCHOOL.

KENYON L. BUTTERFIELD, A.M., LL.D., President of the College.

CHARLES H. FERNALD, Ph.D., Honorary Director of the Graduate School.

CHARLES E. MARSHALL, Ph.D., Director of the Graduate School and Professor of Microbiology.

GRADUATE STAFF, 1918-19.

Professor BEAUMONT, Professor CANCE, Professor CHAMBERLAIN, Assistant Professor O. L. CLARK, Professor CRAMPTON, Professor FERNALD, Professor FOORD, Professor GRAHAM, Assistant Professor ITANO, Professor LINDSEY, Professor OSMUN, Professor PETERS, Professor PHELAN, Professor SEARS, Professor WAUGH, Director MARSHALL, President BUTTERFIELD; Mr. WATTS, Secretary.

Graduate courses leading to the degrees of master of science and doctor of philosophy have been given for a number of years; the degrees of master of agriculture and doctor of agriculture are now granted to meet strictly professional needs. The number of requests for each of these courses is apparently increasing. In recognition of the benefits to be derived from a separate organization, a distinct graduate school has been established for the purpose of fitting graduates of this and other institutions for teaching in colleges, high schools and other public schools; for positions as government, State and experiment-station specialists in farm management, dairying, live-stock husbandry, poultry science, agronomy, landscape gardening, pomology, vegetable gardening and floriculture; for positions as bacteriologists, botanists, chemists, entomologists; and for numerous other positions requiring a great amount of scientific and professional knowledge, training and experience.

ORGANIZATION.

The school is based upon the department as the unit, and the apprenticeship system as the most effective means of instruction. This gives to the student individuality in treatment and an intimacy with actual conditions of work and operations. Besides, each student is assigned to an advisory committee, composed of the instructor in charge of his major subject as chairman, and instructors in charge of his minor subjects as members, which directs his graduate studies. The chairmen of all these committees together constitute the graduate staff, which controls the policy of the graduate school.

ADMISSION.

Admission to the graduate school will be granted: —

1. To graduates of the Massachusetts Agricultural College.

2. To graduates of other institutions of good standing who have received a bachelor's degree substantially equivalent to that conferred by this college.

In case an applicant presents his diploma from an institution of good standing, but has not, as an undergraduate, taken as much of the subject he selects for his major as is required of undergraduates at the Massachusetts Agricultural College, he will be required to make up such parts of the undergraduate work in that subject as the instructor in charge may consider necessary. He shall do this without credit toward his advanced degree.

Admission to the graduate school does not necessarily admit to candidacy for an advanced degree, — students holding a bachelor's degree being in some cases permitted to take graduate work without becoming candidates for higher degrees.

Applications for membership in the graduate school should be presented to the director of the school. Full statements of the applicant's previous training, of the graduate work desired, and of the amount and kind of work already done by him as an undergraduate should be submitted, together with a statement whether the applicant desires to work for a degree.

Registration is required of all students taking graduate courses, the first registration being permitted only after the student has received an authorization card from the director.

Nature, Methods and Requirements of Graduate Work.

Graduate work differs from undergraduate work in its purposes and methods. The primary aims of the instructor are emphasized in an attempt to have the student adjust himself and place himself in his environment; develop the rule of self-direction and self-instruction; acquire the power of accurate reasoning; gain proficiency and skill in his selected field of study or practice; and obtain an appreciative and discriminative insight into experimentation and original research. Methods are not devised, therefore, for attractiveness, entertainment and superficial reviews, but for the creation of initiative and profound thought, thorough acquaintance with detail, independent advance and industrious habits. Careful readings, lectures, conferences, surveys, laboratory exercises and field work are some of the agencies utilized.

All members of the graduate school are required to attend the course of lectures designed to supplement the technical work of all graduate studies. These lectures will be given once each week, and the students will be held responsible for the work. [Suspended during continuance of the war.]

Candidates for the degree of master of science are required to prosecute two subjects, one of which shall be designated as a major and the other as a minor. These subjects may not be selected in the same department. An original thesis is considered a part of the major subject.

Candidates for the degree of doctor of philosophy are required to prosecute three subjects, one of which shall be designated as the major and the others as minors. No two of these subjects may be taken in the same department. An original thesis shall be considered a part of the major subject.

Candidates for the degree of master of agriculture are allowed greater privileges in the selection of subjects, but will be required to select a major and such other supporting lines of study as will be necessary properly to equip the individual professionally.

Candidates for the degree of doctor of agriculture are required to select a major and such other subjects as will develop the major in its greatest intensity and comprehensiveness. Successful experience is also requisite, together with a thesis which represents a masterly survey or intimate study through accurate application of some phase of the major subject.

Candidates for the degree of master of landscape architecture will be expected to conform to the established courses of the department, and to the requirements of the department in the preparation of a thesis, as well as in actual experience outside the college.

Candidates for membership in the graduate school who do not desire to work for a degree may, with the approval of the director of the school, take more than one subject in the same department, or pursue work in several departments, if their preparation will permit. A statement of the subjects chosen must in each case be submitted to the director of the graduate school for approval by the student's advisory committee. The chosen subjects must bear an appropriate relation to each other.

A working knowledge of French and German is essential to successful graduate work, and students not having this will find it necessary to acquire it as soon as possible after entering.

The graduate staff reserves the privilege of recommending and allowing courses in other institutions as a part of residence instruction. Such supervision will be exercised and credit granted as are essential to the highest standards of efficiency.

Theses.

A thesis is required of each candidate for an advanced degree. It must be on a topic belonging to the candidate's major subject; must show that its writer possesses the ability to carry on original study; and must be an actual contribution to knowledge.

The thesis in its final form must be submitted to the director by May 15 of the year in which the student is to present himself for the advanced degree, and before he may take the required examination. Three complete copies are required. One of the said copies is to be retained as an official copy by the said director, one is to be deposited in the college library, and the third is to be retained by the department in which the thesis was prepared. The candidate for the doctor's degree must be prepared to defend at the oral examination the views presented in his thesis.

Final Examinations.

For the degree of master of science, master of agriculture, or master of landscape architecture, final examination, which may be either written or oral, or both, is given upon the completion of each subject.

For the degrees of doctor of philosophy and doctor of agriculture, final examinations on the minors taken are given upon the completion of the subjects. In the major subject, a written examination, if successfully passed, is followed by an oral examination in the presence of the faculty of the school.

Degrees conferred.

The degrees of master of science, master of agriculture and master of landscape architecture are conferred upon graduate students who have met the following requirements: —

1. The devotion of at least one year and a half[1] to the prosecution of study in two subjects of study and research, not less than one full college year of which must be in residence. In the case of a master of landscape architecture the student must follow the prescribed course of study.

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[1] All time statements refer to minimum time.

2. The earning of not less than fifty credits in the chief or major subject, and of not less than twenty-five credits in the minor subject. Students pursuing the course in landscape architecture will devote all of their time to the established course, and meet the conditions of one year of experience outside the college.

3. The preparation of a thesis in the major subject, constituting an actual contribution to knowledge, and accompanied by drawings if necessary.

4. The passing of final examinations, in both major and minor subjects, to the satisfaction of the professors in charge.

5. The payment of all fees and college expenses required.

The degrees of doctor of philosophy and doctor of agriculture are conferred upon graduate students who have met the following requirements: —

1. The devotion of at least three years to the prosecution of three subjects of study and research in residence at the college.

2. The earning of not less than one hundred credits in the chief or major subject, and of not less than twenty-five credits in each of two minor subjects.

3. The preparation of a thesis, in the major subject, constituting an actual contribution to knowledge and accompanied by drawings if necessary. For the degree of doctor of agriculture the thesis may be modified to meet professional requirements.

4. The passing of final examinations, in both the major and minor subjects, to the satisfaction of the instructors in charge.

5. The payment of all fees and college expenses required.

The fee for the degree of master of science, master of agriculture, or master of landscape architecture is $10, and for the degree of doctor of philosophy or doctor of agriculture, $25.

Courses offered.

Courses available as major subjects for the degree of doctor of philosophy: —

Agricultural economics.
Botany.
Chemistry.
Entomology.
Horticulture.
Microbiology.
Rural sociology.

Courses available as major subjects for the degree of master of science: —

Agricultural economics.
Agricultural education.
Agriculture.
Agronomy.
Animal husbandry.
Botany.
Chemistry.
Entomology.
Horticulture.
Mathematics and physics.
Microbiology.
Poultry science.
Rural sociology.
Veterinary science.

Courses available as major subjects for the degree of master of agriculture: —

Agronomy.
Animal husbandry.
Poultry science.

The course in landscape architecture leads to the degree of master of landscape architecture.

Courses available as minor subjects: —

- Agricultural economics.
- Agricultural education.
- Agriculture.
- Agronomy.
- Animal husbandry.
- Animal pathology.
- Botany.
- Chemistry.
- Entomology.
- Horticulture.
- Landscape architecture.
- Mathematics and physics.
- Microbiology.
- Poultry science.
- Rural sociology.
- Zoölogy.

General Outline of Courses for Advanced Degrees.

Agricultural Economics (Major Course). — 1. Graduate research work in agricultural economics will be developed by four principal methods, namely, historical, statistical, accounting and general field investigation. In all instances the method includes facility in investigation, tabulation and interpretation of results.

2. Candidates for the doctorate, the master's degree, or candidates offering a minor in agricultural economics, will be required to pass an examination covering the undergraduate work now offered in agricultural economics, including Course 50, the elements of economics, Course 75, the agricultural market and Course 52, co-operation in agriculture; and in addition such definite research work as may be outlined by the department, to consist of original investigations in some particular divisions of the subject of agricultural economics. Courses 52, 53, 76, 77, 78 and 79 are for graduates and undergraduates. Special investigations may be made by electing seminars 80–82 in agricultural economics.

3. Candidates for the doctor's degree will be required to write a thesis, and candidates for the master's degree a thesis or a report, covering results of a specific line of personal investigation in one or more fields of the subject. Each candidate will also be required to have a working knowledge of the general field of economics, the theory of agricultural economics, the problems of agricultural production, land tenure, land problems, agricultural commerce, agricultural co-operation, agricultural credit, statistics of agriculture and prices, and markets and marketing.

Agricultural Education. — Work offered in this department may be taken as a major or minor for the degree of master of science or as a minor for the degree of doctor of philosophy or master of science. Three lines of study are open to students who are properly qualified, — agricultural education, public school supervision, and the philosophy of education. In order to enter upon any one of these for credit towards an advanced degree the candidate must present evidence of proficiency in at least five courses in agricultural education as outlined for undergraduates, or their equivalent. Open only to persons holding a bachelor of science degree from this college or its equivalent; also to school superintendents, principals and to teachers of successful experience and of mature years, who have the above preparation and who wish to avail themselves of this opportunity for advanced study even though not candidates for a degree.

Agronomy (Master of Science). — Graduate students desirous of taking major work in agronomy should have had a good training in the fundamentals of the natural sciences, since agronomical problems involve the application of the natural sciences especially. They should have taken Agronomy

27 and 50, or their equivalents, and other courses given by this department along the line of the problem on which they will work, and should have a command of the laboratory technique required for their problems. Problems may be chosen in which particular attention is devoted to soils, fertilizers or field crops. The specific problem is selected in conference with the major adviser, consideration being given to the student's desires and abilities.

Although this department does not attempt to limit the field of research in agronomy, the following phases are suggested to the prospective graduate student: —

I. SOILS AND FERTILIZERS. — (*a*) Soil physics: Textural relationships of soil classes; adsorption phenomena; physical properties in relation to mineralogical and chemical properties; soil structure; moisture relationships; the colloidal conditions of soils, etc.

(*b*) Soil chemistry: Nitrogen fertilization, including commercial supply and gain or loss under different systems of soil management; absorption of potash and phosphoric acid; sulfur fertilization; soil acidity, etc.

(*c*) Soil biology: Fixation of nitrogen by symbiotic and nonsymbiotic organisms; changes of green and animal manures in the soil, — ammonification and nitrification; care and preservation of manures; humus in relation to soil fertility, etc.

II. FIELD CROPS. — (*a*) Varieties: Classification; adaptation to climatic and soil conditions, etc.

(*b*) Distribution as affected by natural and economic conditions.

(*c*) Cultural methods: Early and late planting of the potato seed crop, of silage corn; spacing of plants; keeping qualities as affected by time and methods of harvesting; tillage and moisture control, etc.

(*d*) Storage of cereals, roots and tubers as affected by aeration, temperature, humidity, previous treatment, etc.

(*e*) Crop improvement, involving the application of the principles of plant-breeding to special crops.

After the selection of a topic for investigation the student is required to formulate the problem in detail, develop a line of attack, carry on the work and present the results in a thesis acceptable to the staff of the Graduate School. The student is required to familiarize himself with the literature bearing on the subject.

A graduate student taking a minor in this department will be required first to take certain of the regular courses offered by the department, unless he has already had them or their equivalents. The work assigned will then depend somewhat on the time required to complete these courses.

It is the aim of the department to supply laboratory, greenhouse and field facilities for attacking agronomical problems through most of the known means. These facilities are intended primarily for the use of graduate students doing major work in agronomy, but others will be allowed to use them when circumstances permit.

Animal Husbandry (Master of Science). — COURSE A. ANIMAL BREEDING. — 1. Reading: Thorough survey of the scientific works dealing with plant and animal breeding and improvement.

2. Project: Each student must outline and pursue some Mendelian problem.

3. Thesis: This is to be a complete treatise of the problem which the student undertakes; it should be a valuable contribution to the present knowledge of the question of animal breeding.

Course B. Animal Nutrition. — This course is in outline similar to A. It is designed to cover the field of nutrition, feeding and management of live stock.

Seminar: Regular periods will be devoted to a discussion of the projects undertaken, together with criticisms of the available material on the question pursued.

Object. — To give the student a comprehensive knowledge of feeding, breeding and management of live stock. This may be divided into a major and a minor, in order to give the student the opportunity of devoting a proportionate share of his time to the class of live stock in which he is particularly interested.

Reading. — The student is to make a very complete survey of experimental and periodical literature dealing with the various phases of the subject.

Practice. — Before the completion of the work for the degree, the student must have the equivalent of at least one year's continuous work on an approved live-stock farm.

Seminar: Regular periods to discuss progress of the work.

Animal Pathology (Minor Course only). — 1. Reviews in anatomy.

2. Reviews in organography and histology.

3. Special lectures and readings in general and special pathology.

4. Laboratory studies in general and special pathology.

5. Pathological technique.

6. Conferences.

Botany (Major Courses). — The equivalent of certain undergraduate courses, determined in the case of each student by the department, is prerequisite. Candidates for the degree of master of science are required to pass a final examination in writing. A final examination in writing before the department and an oral examination before the graduate staff must be passed by candidates for the degree of doctor of philosophy. Candidates for the latter degree are required to attend all graduate lectures given by the department. Candidates for the degree of master of science will take those lectures given during their period of study in the department. All lecture courses will be given in rotation, except Courses 1 and 2, which will come every year. There will be three lectures a week throughout the fall, winter and spring terms. These lecture courses, outlined below, are designed to cover a period of three years.

1. Plant Physiology. — The lectures will consider, under the nutrition of the plant: its chemical structure, absorption of various nutrient substances and their changes in the plant, assimilation and dissimilation of carbon and nitrogen by autotrophic and heterotrophic plants; under changes in the form of plants: growth and form under constant external factors, the influence of variable external and inner factors on growth, form and development; and under plant movements: the various tropisms, nutations, etc. Supplemental demonstrations, laboratory work and readings in the standard texts and journals. One lecture a week for 36 weeks.

2. Plant Pathology. — A general consideration of the history, nature and causes of plant disease; parasitism, predisposition, immunity, degeneration, natural and artificial infection, dissemination, epidemics, biologic strains, monstrosities and malformations, proliferation, prevention and control, economics of plant diseases. One lecture a week for 36 weeks.

3. Normal and Pathogenic Metabolism. — The lectures in this subject embrace, in more or less detail, comparative consideration of the metabolism

of the host in health and disease; the metabolism of the parasite under varying conditions; enzyme activities in host and parasite; methods of preparation and determination of enzyme activities; chemical and physical changes induced in plant tissue by parasites; immunity, etc. Current investigations and new phases of the subjects under discussion will also receive attention as they appear. One hour a week for 24 weeks.

4. THE COMPARATIVE ANATOMY OF GREEN PLANTS. — In these lectures an intensive study is directed to the comparative anatomy of green plants from the evolutionary standpoint. Particular emphasis is laid upon the woody forms both living and extinct. Of the latter the department is fortunate in possessing excellent sets of micro-preparations and lantern slides. Two lectures and one laboratory period for 24 weeks.

5. BIOLOGIC RELATIONS. — Consideration of certain phases of the morphological and physiological adaptations of plants with regard to insect visit; the rôle of thorns, hairs, tendrils, glands, etc. Various experiments will be made to test out experimentally some of the existing theories concerning biologic adaptations. One lecture a week for 12 weeks.

6. THE ECOLOGY OF PLANTS. — This course deals with the water, light and temperature relations of plants, and the various adaptations in response to these factors; the various types of plant formation; the migration of plants; the competition of plants; invasion and successions of plants under varied conditions; and the various types of alternations and zonations. One lecture a week for 12 weeks.

7. PHYSIOLOGICAL PLANT PATHOLOGY. — This course considers those plant diseases not due to bacterial or fungous parasites, but resulting from unfavorable physical or chemical conditions of the soil; from harmful atmospheric influences, such as too dry air, too much moisture, hail, wind, lightning, frost; from injurious gases and liquids; from lack of or too much light; from wounds. A knowledge of the normal physiology of the plant is required. Demonstrations and laboratory work will be given, together with assigned readings. One lecture a week for 12 weeks.

8. HISTORY OF BOTANY. — A historical survey of the science; lives of noted botanists; history of certain culture plants, such as wheat, corn, coffee, potato, rice, and their influence on civilization; reading. One lecture a week for 18 weeks.

Seminar: A weekly seminar for members of the department staff, graduate students and major senior students is held, at which important current botanical papers are discussed. Attendance and participation are required.

Collateral Reading: Extensive reading of botanical literature in English, German and French, designed to give the student a broad knowledge of the science, is required of all major students. Final examinations are based in part upon this reading course.

Thesis: Each major student is required to select a problem in plant pathology or physiology (in other branches at the discretion of the department) for original investigation, and the thesis must embody a distinct contribution to knowledge. An effort will be made to assign problems having some bearing on scientific and economic agriculture.

Minor Course. — For a minor a student may take such of the work offered by the department as seems best suited to his major course. In most cases no problem will be assigned.

Professor OSMUN, Dr. CHAPMAN, Professor ANDERSON,
Assistant Professor CLARK and Dr. TORREY.

Chemistry. — I. Major courses for the degree of master of science. Students will be required to take Courses 101, 108 to 114. In addition to this the requirements in the various thesis subjects are: —

ORGANIC AND BIO-CHEMISTRY. — Courses 115 and either 105, 106 or 107, and 6 hours for one term selected from Courses 103 (*b*) and (*f*), and 104.

ANALYTICAL AND INDUSTRIAL AGRICULTURAL CHEMISTRY. — Courses 116, 103 (6 hours), and 6 hours for one term selected from Courses 102, 104 to 107.

PHYSICAL CHEMISTRY. — Courses 104, 117, and 6 hours for one term selected from Courses 102, 103, 105 to 107.

AGRICULTURAL CHEMISTRY. — Courses 103 (6 hours), 118, and 6 hours for one term selected from Courses 102, 104 to 107.

The candidate must pass a final written and oral examination before the Department of Chemistry upon undergraduate Courses 1 to 80, inclusive, and upon all graduate work taken in chemistry by him.

II. Major course for the degree of doctor of philosophy. Students will be required to take Courses 101 to 114, and one course selected from 115 to 118. In addition, the student may be required to spend at least two terms or one semester at some other recognized institution pursuing graduate work in chemistry. The candidate must pass a final written examination before the Department of Chemistry, and an oral examination before the graduate staff, upon the whole field of chemistry, and must be especially well prepared in the lines of work covered by his research.

III. Minor course for the degrees of master of science and doctor of philosophy. Students will be required to take work totaling at least 25 credits. This may be selected from any of the undergraduate Courses 27 and 51 to 80, or any of the graduate courses for which the student is prepared. In addition, the candidate must pass a final written and oral examination before the Department of Chemistry upon the courses taken and upon undergraduate Courses 27 and 51 to 80.

The following is a list of the courses: —

101. INORGANIC PREPARATIONS. — Laboratory. The preparation of chemical products from raw materials. The manufacture and testing of pure chemicals. The laboratory work is essentially synthetic in nature, and is designed to aid in acquiring a more adequate knowledge of inorganic chemistry than is to be obtained by chemical analysis alone. Ten to fifteen of the preparations given in Biltz's "Laboratory Methods of Inorganic Preparations" will be made by each student. Any term, 6 hours.

Assistant Professor SEREX.

102. ADVANCED INORGANIC PREPARATIONS. — Laboratory. Continuation of Course 101. Any term, 6 hours.

Assistant Professor SEREX.

103. ADVANCED ANALYTICAL CHEMISTRY. — Laboratory. This course may be taken in part as follows: (*a*) electrolytic analysis, 6 hours; (*b*) ultimate analysis, 6 hours; (*c*) special analytical work to meet the needs of the individual student, 6 hours. In addition, parts of undergraduate Courses 62, 76 and 77 may be taken, as follows: (*d*) fertilizers, 6 hours; (*e*) insecticides, 6 hours; (*f*) milk and butter, 6 hours. (*a*), (*b*), (*c*) may be taken any time; (*d*), (*e*), (*f*) must be taken at the time the undergraduate course is given.

Professors WELLINGTON and PETERS.

104. ADVANCED PHYSICAL CHEMISTRY. — Laboratory. Measurement of the electrical conductivity of solutions; degree of ionization; ionization constants; per cent hydrolysis of aniline hydrochloride from conductivity measurements; solubility product by the conductivity method; velocity of saponification by conductivity; neutralization point by conductivity; vapor pressure determinations; critical temperature of carbon dioxide or sulphur dioxide; transport numbers; preparation and properties of colloidal solutions; transition points by dilatometric method; heat of solution of ammonium chloride and potassium nitrate; adsorption of iodine by charcoal; splitting of racemic glycerinic or racemic tartaric acids into their optical components. To each student separate work will be assigned. Any term, 6 hours.

Assistant Professor SEREX.

105. ADVANCED ORGANIC PREPARATIONS. — Laboratory. The preparation of compounds not included in Courses 51 and 52, such as the Kolbe synthesis of salicylic acid; benzophenone and Beckmann's rearrangement; rosaniline, malachite green, congo red, indigo and other dyes; synthesis of fructose; Grignard reaction. Barnett, Cain and Thorpe, Gatterman, Noyes, Fischer and other laboratory guides are used. To each student separate work will be assigned. Any term, 6 hours.

Professor CHAMBERLAIN.

106. ADVANCED BIO-CHEMISTRY. — Laboratory. The hydrolysis of proteins and isolation of the amino acids; the study of milk, blood and urine; dietary and digestion studies. References: Abderhalden, Plimmer, Salkowski, Hawk, etc. To each student separate work will be assigned. Any term, 6 hours.

Professor CHAMBERLAIN.

107. INDUSTRIAL ORGANIC CHEMISTRY. — Laboratory. The preparation, on a large scale, of wood alcohol, acetic acid, ethyl alcohol, benzene and cellulose products, such as mercerized cotton and artificial silk. References: Molinari, Rodgers and Aubert, Thorpe, Enzyklopädie der tech. Chemie, etc. To each student separate work will be assigned. Any term, 6 hours.

Professor CHAMBERLAIN.

108. THEORETICAL CHEMISTRY. — Lectures. The following topics are considered: the compressibility of the atoms; the structure of atoms; the electron conception of valence. First term, 1 hour. Alternates with Course 109.

Professor PETERS.

109. ANALYTICAL CHEMISTRY. — A general survey of methods and technique covering processes commonly carried out in the laboratory. Gooch's Quantitative Analysis is used as a text. First term, 1 hour. Alternates with Course 108.

Professor PETERS.

110. ORGANIC CHEMISTRY. — Lectures. Some of the following topics will be considered both theoretically and industrially: alkaloids, synthetic dyes, essential oils, terpenes, rubber, etc.; the study of methods for carrying out general reactions; isomerism, tautomerism, condensation, etc. References,

Cain & Thorpe, Cohen, chemical monographs, Lassar-Cohn, Heinrichs, Molinari. Second term, 1 hour. Given in 1916–17. Alternates with Course 111.

Professor CHAMBERLAIN.

111. BIO-CHEMISTRY. — Lectures. Some of the following topics will be considered both chemically and physiologically: fats, cholesterol, lecithin, carbohydrates, amino acids, proteins, urea, uric acid, purine bases, enzymes, fermentation, animal food and nutrition, photosynthesis. References, Monographs on Bio-Chemistry, Abderhalden, Plimmer, Haas & Hill, Lewkowitsch, Fischer, Euler, Mathews, Czapek. Second term, 1 hour. Given in 1917–18. Alternates with Course 110.

Professor CHAMBERLAIN.

112. THEORETICAL AND PHYSICAL CHEMISTRY. — Lectures. The relation between the constitution and properties of compounds; mutarotation; steric hindrances; stereoisomerism of other elements than carbon; molecular association; similarity between the compounds of silicon and carbon. Third term, 1 hour. Given in 1917–18. Alternates with Course 113.

Assistant Professor SEREX.

113. THEORETICAL AND PHYSICAL CHEMISTRY. — Lectures. Radioactivity; the application of physical chemistry to industrial chemistry. Third term, 1 hour. Given in 1916–17. Alternates with 112.

Assistant Professor SEREX.

114. SEMINAR. — Conferences, reports or lectures. Three terms, twice a month, 1½ hours.

Professor LINDSEY.

115. RESEARCH IN ORGANIC AND BIO-CHEMISTRY. — Three terms. A minimum of 20 hours' laboratory work per week. Credit determined by amount of work done.

Professor CHAMBERLAIN.

116. RESEARCH IN ANALYTICAL OR AGRICULTURAL INDUSTRIAL CHEMISTRY. — Three terms. A minimum of 20 hours' laboratory work per week. Credit determined by the amount of work done.

Professor WELLINGTON and Professor PETERS.

117. RESEARCH IN PHYSICAL CHEMISTRY. — Three terms. A minimum of 20 hours' laboratory work per week. Credit determined by amount of work done.

Assistant Professor SEREX.

118. RESEARCH IN AGRICULTURAL CHEMISTRY. — Three terms. A minimum of 20 hours' laboratory work per week. Credit determined by amount of work done.

Professor LINDSEY and EXPERIMENT STATION ASSOCIATES.

Entomology. — I. Major Courses for the degree of doctor of philosophy. Students must have had the undergraduate courses in entomology given at this college, or their equivalent. If deficient in any, opportunities to obtain them while taking the graduate work are available.

The graduate courses consist of lectures on all, and laboratory work on a part, of the subjects given below, together with advanced readings, seminar work and original research.

1. Morphology. — The embryonic development of insects, including polyembryony; metamorphosis and its interpretations; advanced studies on external and internal anatomy and histology; the ancestry and development of insects, including fossil forms; hermaphrodites; hybrids; parthenogenesis, pedogenesis and heterogeny; the chemistry and physics of insect colors; color patterns, their significance and value; light production in insects; deformities; variation.

2. Ecology. — Dimorphism and polymorphism, seasonal and sexual; mimicry, concealment, protective devices and warning coloration; architecture of insect constructions; the fertilization of plants by insects and its importance; insect products of value to man; the geographical distribution and methods of distribution of insects, including a consideration of life zones, barriers, etc.; insect migrations; the relation of insects to disease (advanced course); duration of life; experimental entomology on insect behavior.

3. Economic. — Control methods; insect photography and methods of preparing illustrations for the press; field work and life history investigations, with ways of keeping records of these; legislation about insects; tests of insecticides and of their application.

4. Systematic. — The history of entomology; the rules of nomenclature and how they are applied; how to find the literature of the subject and how to use it; the abundance of insects; important collections, their location, value to the entomologist, their types and their condition; lives and work of prominent entomologists; methods for collecting, preparing, preserving and shipping insects.

5. Seminar. — Readings and reports on the current literature on entomology are held monthly.

6. Collateral Readings. — The best articles on the topics above and on the different groups of insects are assigned for collateral reading.

7. Thesis. — Original research on one or several topics in morphology, ecology, economic lines or systematic work will require one-half to three-quarters of the time spent. The thesis must give the results of original investigation and be of sufficient merit for publication.

II. A major course for the master of science degree will be about half of the above.

III. Minor Courses will cover such parts of the work outlined above as will be most likely to prove useful in connection with the majors taken by the students, or in their future work. It is not required that such men shall have had all the undergraduate work in entomology given at this college, their credit for a minor beginning where their own undergraduate training in the subject ended.

Horticulture. — Graduate work is offered in various lines of horticulture. For the most part this is divided into the different departments which now constitute the college Division of Horticulture, as follows: pomology, floriculture, landscape gardening, forestry and market gardening. For work in these lines application should be made direct to the heads of the several departments.

Besides this work, however, opportunity is offered for graduate study in general horticulture, including topics from the several organized departments mentioned, and also questions relating to plant breeding, general evolution, propagation, manufacture of horticultural products, etc. This general work is under the direction of Prof. F. A. Waugh, head of the Division of Horticulture.

Landscape Architecture (Major Course). — Every student before receiving his master's degree in landscape gardening must have given some thorough and fruitful study to each of the following five departments. As far as possible these studies must be of a practical nature, *i.e.*, they must be made upon actual projects in progress of development.

1. THEORY. — The principles of esthetics as applied to landscape gardening.
2. DESIGN. — The principles of pure design and their application in landscape and garden planning.
3. CONSTRUCTION. — The practical methods of carrying out landscape plans, laying out, equipment, organization of working force, time and cost keeping, etc.
4. MAINTENANCE. — Methods, organization, cost.
5. PRACTICE. — Office work, drafting, estimating, reporting, charges, accounting.

Qualifications. — Each student before he may receive the master's degree with a major in this department must convince his instructors that he has a genuine aptitude for some branch of landscape gardening, either in design, construction or management.

The minimum period of graduate study will be one and one-half years. At least one year of this time must be spent in residence at the college, and also one year must be spent in practice outside the college. The work done outside the college may be prescribed by the department, and must be fully reported to the department in writing. It is essential, further, that the candidate secure the written approval of his employers outside the college. The department may, at its discretion, require a longer period of study at the college or a longer apprenticeship outside the college.

Thesis or Project. — Each student before receiving the master's degree with a major in landscape gardening must present a satisfactory thesis or complete project. A thesis will consist of a careful original study of some problem in landscape architecture, presented in typewritten form with any necessary illustrations, such as photographs, diagrams, drawings, etc. A project will consist of a completed set of studies of some suitable landscape-gardening problem, such as the design of a park, a real estate subdivision, an extensive playground. Such a project will usually consist of —

(*a*) Original surveys, including topography.
(*b*) Block plans, showing original design.
(*c*) A rendered plan or plans of the main features.
(*d*) Detailed working drawings.
(*e*) Estimates of cost.
(*f*) Complete report and letter of transmittal.

Minor Course. — Any student electing a minor in landscape gardening will be directed to take such courses from the regular catalogue list as may seem most suitable for him. Under ordinary circumstances no other work will be given to students electing minors. In special cases, however, individual problems will be assigned and individual instruction given. These exceptions will be made in cases where, by so doing, it is possible to give the student material assistance in the plan of his major work.

Prerequisite Work. — The undergraduate courses in the college known as Landscape Gardening 50, 51, 52 and 53, Drawing 25, 26, 27, Horticulture 27, 50, 51, and Mathematics 26 and 27 will be considered prerequisite to graduate work, and any student not having passed these courses or their equivalent will be required to make up such work without graduate credit. Courses known as Landscape Gardening 75, 76, 77, 78 and 79 are required and may or may not be accepted for graduate credit, at the discretion of the department.

Microbiology. — I. Courses leading to the Degree of Doctor of Philosophy. — 1. The candidate must present twenty-five credits from the undergraduate study as furnished in undergraduate Courses 50, 51, 52, 80, 81 or an equivalent before he can enter upon graduate study.

Note. — Twenty-five credits are required of undergraduates majoring in microbiology.

2. The candidate must pursue successfully the following special courses or their equivalent. These courses are designed to give a comprehensive survey of the fields indicated, and are arranged especially for graduate students.

175. Agricultural microbiology,	5 credits.
176. Agricultural microbiology,	5 credits.
182. Dairy microbiology,	5 credits.
183. Food microbiology,	5 credits.

Note. — Courses 175, 176, 180, 181, 182, 183 correspond in subject-matter with Courses 75, 76, 80, 81, 82, 83 of undergraduate study; the latter courses are elementary in nature, while the former are arranged for intensive advanced study of graduate character. Candidates will be required not only to perform the exercises of the above courses, but will be expected to assist in teaching the elementary classes covering the same theme as a part of graduate requirements.

3. It will be necessary to complete additionally the following courses or their equivalent, open only to graduate students: —

190. I. 1920. Studies in technique, as photomicrography, laboratory equipment and manipulation.[1]
5 to 10 credits. Assistant Professor Itano.

151. II. 1921. Cytological and morphological studies and technique.[1]
5 to 10 credits. Professor Marshall and Mr. Neill.

152. III. 1922. Physiological studies.[1]
5 to 10 credits. Assistant Professor Itano.

177. II. 1922. Microbial studies in agriculture. Specific subjects.[1]
5 to 10 credits. Professor Marshall, Assistant Professor Itano and Mr. Neill.

181. II. 1923. Advanced sanitary or hygienic studies.[1]
5 to 10 credits. Professor Marshall and Assistant Professor Itano.

150. I, II, III. Lectures and study of literature.[2]
10 credits. Professor Marshall, Assistant Professor Itano and Mr. Neill.

200. I, II, III. Research.[3] (Some microbiological problem related to agriculture.)
40 to 50 credits. Professor Marshall, Assistant Professor Itano and Mr. Neill.

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[1] Repeated every three years.

[2] Continues over three years, once each week.

[3] Distributed as may be most beneficial for research work. Time and credit by arrangement.

The thesis prepared must be satisfactory to the department and the graduate staff, and the candidate must be ready to defend it at his public examination. Further, following the presentation of the thesis, the candidate must submit to a written examination covering the entire subject by the department and a public oral examination under the auspices of the graduate staff.

II. COURSES LEADING TO THE DEGREE OF MASTER OF SCIENCE. — 1. Prerequisite studies, as in the case of the degree of doctor of philosophy (I, 1).

2. Special studies as represented by courses —

175. Agricultural microbiology,	5 or 10 credits.
176. Agricultural microbiology,	5 or 10 credits.
182. Dairy microbiology,	5 or 10 credits.
183. Food microbiology,	5 or 10 credits.

3. Courses designed for graduate students only.

150. I, II, III. Lectures and study of literature.
5 credits. Professor MARSHALL, Assistant Professor ITANO and Mr. NEILL.
200. I, II, III. Research.[1] (Some microbiological problem related to agriculture.)
15 to 25 credits. Professor MARSHALL, Assistant Professor ITANO and Mr. NEILL.

The thesis submitted must be satisfactory to the department and to the graduate staff.

The candidate will be required to take a written examination and an oral examination by the department.

III. MINOR WORK IN MICROBIOLOGY. — May consist of Undergraduate Courses 50, 51, 52, and one other course, designed to support his major work, from among Courses 175, 180, 181, 182, 183. He will also be required to pursue Graduate Course 150 through four terms (see II, 3, 150). In case the candidate has had some of these courses, he will be required to take more advanced substitute courses. A written examination over the subject-matter covered will be given at the close of the work.

Poultry Science (Major Course for the Degrees of M.S. and M.Agr.). — 1. READING. — A review of the entire field of poultry literature, covering books, bulletins and special articles, is made, and a written report on one or more subjects required.

2. SEMINAR. — A critical review and a criticism of the more important experiments carried on at the various stations in this and other countries; also a study of poultry conditions in foreign countries, methods of management, etc., besides a detailed study of some of the largest poultry projects in this country.

3. ANATOMY (GROSS AND HISTOLOGICAL), PHYSIOLOGY AND SURGERY. — This course requires a careful study of the anatomy and physiology of the fowl. Special attention is given to a study of those structures concerned with practical poultry problems. Instruction in surgical technique, adapted to fowls, may also be given.

4. BREEDING. — The student will carry on such breeding experiments as time and facilities permit. He may also do work in connection with our regular experimental projects. A detailed study of the pertinent literature will be required. Animal Husbandry 5, or its equivalent, is a prerequisite.

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[1] Distributed as may be most beneficial for research work. Time and credit by arrangement.

5. Feeding. — A study of the relation of various foods and other substances to the morphology and physiology of the bird, with special reference to such subjects as egg production, feather form and structure, condition of flesh, bone, etc.

6. Brooding.—Studies will be made upon the relation between viability and rate of growth and the following topics: type of brooder, number of chicks in brood, ventilation, humidity, sanitation, exercise and weather conditions; also a comparison of natural methods with artificial methods of rearing chicks.

7. Incubation and Embryology. — A number of problems of a practical, scientific and mechanical nature relating to incubation are considered. The work in embryology is of an advanced nature dealing with its relation to morphogenesis and heredity, and presupposes an elementary knowledge of the embryology of the chick.

8. Poultry Diseases and Sanitation. — In this course a study is made of various problems in poultry sanitation, with particular reference to methods relating to the control and eradication of disease.

9. Thesis. — A thesis based on first-hand work on some problem in poultry biology or husbandry is required of all students working for the M.S. degree, and may be required of those working for the M.Agr. degree.

Note 1. — The postgraduate course presupposes all undergraduate work or its equivalent, together with practical experience. Without the latter, students will be unable to handle Courses 5, 6 and 7. At the discretion of the instructor in charge, graduate students may be required to pursue undergraduate courses in other departments without credit.

Note 2. — Practical poultry work may be required, but no credit will be given for such work.

Note 3. — Courses 1 and 2 are designed particularly for minors.

Rural Sociology. — Courses are offered in Rural Sociology as major or minor subjects for the degree of doctor of philosophy.

Candidates for the master's degree will be required to pass an examination in all courses offered by this department primarily for undergraduates, as shown in the departmental classification. In addition they will be required to select one or more of the divisions of the subject for intensive study and research, as indicated below.

A thesis showing the results of personal investigation on some particular topic or topics must be presented. The thesis must show familiarity with the material bearing on the subject, ability in discovering and utilizing original sources, judgment in evaluating facts, evidences and authorities, originality and independence of thought. It must be a contribution in a very definite way to rural sociological thought.

Topics for Study and Research.

1. The rural community: —
    - (*a*) Historical development.
    - (*b*) Influence of modern conditions on family and community life.
    - (*c*) Problems and methods in community organization.
    - (*d*) Community planning in Massachusetts.
2. Origin and development of rural institutions: —
    - (*a*) Scope, function and influence of educational institutions on rural social progress. Plans for betterment.
    - (*b*) History of the development of the rural church, its problems and program for improvement.
    - (*c*) The farm family, in its relation to religious, cultural, educational and social agencies. The relation of the standard of living to rural social progress.

3. Rural organization: —
    - (*a*) The scope and function of rural organization in development of rural life.
    - (*b*) Work of the national government in rural organization.
    - (*c*) County and institutional work in rural organization.
    - (*d*) Leadership in its relation to organization.
4 Rural government and rural law: —
    - (*a*) Development of rural local government in New England and the west. Progress in efficient local self-government.
    - (*b*) Relation of the State to the farmer, influence of the farmer in legislation, the organized ways and means by which the State aids the farmer directly.
    - (*c*) Work of the national government in its relation to the social welfare of the farming people.
    - (*d*) Agrarian legislation in the United States and Europe affecting rural social welfare.
5. Farmers' organizations: —
    - (*a*) Social problems underlying farmers' organizations in reference to service and permanency.
    - (*b*) Principles of organization.
    - (*c*) History of farmers' organizations in the United States.
6. Rural social and sociological surveys: —
    - (*a*) An intensive study of the place and function of statistical data in the sociological field, its evaluation and interpretation.
    - (*b*) A critical study of social surveys of rural life and methods of survey, with a view to discovering the strength and weakness of each.
7. Social condition of the rural people: —
    - (*a*) Origin and development of rural ideals.
    - (*b*) The status of the rural people in relation to health, morality, crime, etc.
    - (*c*) Problems of social psychology arising in rural life.

The course required for candidates offering a minor will be arranged after a conference with the director of the department, and will take into consideration the needs of the student in view of his previous preparation. The amount of time required of the student for his minor work will correspond with the requirements of the graduate school.

Veterinary Science. — Work is available in anatomy, hygiene, veterinary pathology, medicine, surgery, parasitology and other special lines or divisions of the subject.

Zoölogy. — Courses in zoölogy may be available as a minor for the degree of master of science and as a minor for the degree of doctor of philosophy. The nature of the work will necessarily vary according to circumstances, and may be intensive in a special field and correlated closely with the major work of the student, or it may be of a more general character, depending on the student's needs or previous acquaintance with general zoölogical science. The time devoted to zoölogy as a minor for either of the above-named degrees may vary from 12 to 16 hours per week, pursued for a year and a half.

List of Students.

A list of the degrees conferred in the Graduate School, and of the students enrolled, is given in the general lists at the end of the volume.

THE SHORT COURSES

THE SHORT COURSES.

The short courses offered by the Massachusetts Agricultural College are designed to meet the needs of those, both young and old, who cannot come to the college for the regular agricultural courses. They furnish the student with instruction in modern accepted methods and are planned to help the farmer and the housewife.

The short courses include: —

A. The Two-year Course in Practical Agriculture.
B. The Ten Weeks' Winter School.
C. The Summer School.
D. The Vocational Poultry Course.
E. Unit Courses.
F. The Regional School.

REQUIREMENTS FOR ADMISSION TO SHORT COURSES. — Students must be at least seventeen years of age and must furnish satisfactory evidence of good moral character. References are required. There are no entrance examinations. The sole test is ability to do the prescribed work. Students enrolling for the Two-year Course in Practical Agriculture must have at least a common school education.

EXPENSES OF SHORT COURSES. — The expense of attending any of the short courses is approximately as follows: —

Furnished rooms in private houses (per week),	$3 to $5
Board at college dining hall (per week),	$7
Board with private families (per week),	$6.50 to $9
Registration fee (Ten Weeks' Winter School),	$5

Tuition in all the short courses is free to residents of the Commonwealth. Small laboratory fees are charged in some of the courses.

A. TWO-YEAR COURSE IN PRACTICAL AGRICULTURE.

The Two-year Course in Practical Agriculture is offered to meet the needs of students who for one reason or another cannot take the four-year college course. It is designed to provide the largest amount of practical information and training in agriculture and horticulture in the shortest possible time consistent with thoroughgoing work. This course is open to men and women seventeen years of age or over who have at least a common school education.

This course is especially arranged and suited for young men and women who expect to make a business of some line of agricultural work, such as dairying, livestock raising, poultry, horticulture, general farming, etc.

It will appeal not only to young men and women but also to men and women of mature years and practical experience who wish to know more about the business of farming. Although the course is planned to meet the needs of those who are not graduates of high schools, the instruction is not preparatory or elementary in its nature, but is so planned that it will be of value to all. The greater amount of academic training that some of the students may possess will in a measure be offset by the fund of practical knowledge possessed by many who have completed only the elementary schools.

The course is not intended for students enrolled in high schools. Such students should finish the high school course. Students enrolled in high schools who wish to take the course should bring a statement either from the principal of the high school or from parent or guardian asking permission to be enrolled.

The Two-year Course in Practical Agriculture is so arranged that the student receives instruction in fundamental subjects and is given an opportunity to select the lines of work during the second year in which he is particularly interested.

As now organized it makes available to the student three courses in agronomy, five courses in animal husbandry, five courses in fruit growing, six courses in rural engineering, five courses in dairying, four courses in poultry, four courses in rural home life, one course in farm manufacturing, three courses in forestry, four courses in farm business, one course in hygiene and sanitation, one course in English, three courses in vegetable gardening, three courses in floriculture, one course in insect pests and two courses in botany. The advantages of the college staff of specialists and the college plant with all its resources are thus made available to young men and young women who may not have had the opportunity of securing a high school education.

The first year consists of six months of study at the college. The term begins with the college fall term and closes with the winter term of the regular session. The same vacation periods are observed as in the regular four-year course.

At the close of six months of study, students are required to gain six months of farm experience. The college will assist students in finding positions and in placing them on farms where the experience gained will be of great advantage. Thus, an effort will be made to place on a dairy farm the man expecting to take up dairying as his chief line of work, and a student of pomology on a fruit farm.

During the second year the student spends nine months in resident study. He is required to select from the following list of major subjects two which he will carry throughout the year, in addition to the required courses: fruit growing, dairying, poultry husbandry, vegetable gardening, floriculture, general horticulture and rural home life.

Each student is required to file with the treasurer of the college a statement, signed by the town (or city) clerk of the town (or city) from which he enrolls, stating that the parent or guardian of the student is a resident of that town.

Certificate. — All students will receive a certificate showing their standings in courses in which they were registered. Credits earned in the Two-year Course in Practical Agriculture or in any other of the short courses do not lead to the college degree. Students who possess college entrance requirements and who wish to take the regular college work should address the registrar of the college.

The Course of Study of the Two-year Course in Practical Agriculture.

First Year.

Required Courses.

First Term.		*Second Term.*		*Third Term.*
Soil Fertility,	3	Principles of Feeding,	3	Six months' farm experience.
Types and Breeds,	5	Fruit Growing,	3	
Fruit Growing,	3	Repair of Farm Equipment,	2	
Sanitation and Hygiene,	3	Dairy,	3	
		Poultry,	3	

Electives.

First Term.		*Second Term.*	
Farm Machinery,	3	English,	2
English,	3	Farm Law,	5
Farm Structures,	5	Rural Home Life,	3
Rural Home Life,	3	Farm Arithmetic,	3
Farm Arithmetic,	3	Agricultural Opportunities,[1]	1
Agricultural Opportunities,[1]	1		

Second Year.

Required Courses.

First Term.		*Second Term.*		*Third Term.*	
Insect Pests,	5	Farm Management,	5	Plant Diseases,	5
Feeding and Management,	3			Marketing,[2]	5
				Social and Economic Problems,	3

Two electives must be chosen from the following list and carried throughout the second year: —

First Term.		*Second Term.*		*Third Term.*	
Fruit Growing,	5	Fruit Growing,	5	Fruit Growing,	5
Dairy,	3	Dairy,	3	Dairy,	3
Poultry,	5	Poultry,	5	Poultry,	5
Vegetable Gardening,	5	Vegetable Gardening,	5	Vegetable Gardening,	5
Floriculture,	5	Floriculture,	5	Floriculture,	5
General Horticulture,	5	General Horticulture,	5	General Horticulture,	5

Additional electives from which the student may choose, one in the winter and two in the spring term: —

First Term.		*Second Term.*		*Third Term.*	
Farm Manufacturing,	3	Animal Breeding,	3	Crops,	5
Rural Home Life,	3	Carpentry,	3	Animal Diseases,	3
		Dairy Bacteriology,	3	Agricultural Credit,[2]	5
		Rural Home Life,	3	Drainage and Irrigation,	3
				Rural Home Life,	3
				Gas Engines,	5
				Feeding and Management,	3

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[1] Required for women students.

[2] This course will not be given during 1920.

B. THE WINTER SCHOOL.

The Winter School, beginning usually about January 1 and continuing for ten weeks, was started several years ago and has always been very popular, not only with more mature farmers and their wives, but with young men and women who control or manage farms. The courses, though short, are very practical in their nature, and are so arranged that a student may choose such subjects as will enable him to specialize along the line of work in which he is most interested. There is a wide range in the choice of subjects, making it possible for the student to take work for several winters in succession. Many college graduates enroll for the Winter School.

Scholarships. — The Jewish Agricultural and Industrial Aid Society of New York has instituted a system of free scholarships to enable the children of Jewish farmers to attend the short winter course in the States in which they reside. The stipend is sufficient to pay all the expenses of the holder for the course; such expenses usually amount to from $100 to $150. The following courses are offered: —

Outline of the Ten Weeks' Winter School, December 30 to March 5.

Soil Fertility. Professor Beaumont. Three lectures a week.
Field Crops. Two lectures and one two-hour laboratory period per week.
Types and Breeds of Livestock. Three lectures and two two-hour laboratory periods a week.
Livestock Feeding. Three lectures per week.
Animal Breeding. One lecture and one two-hour laboratory period per week.
Dairying. Professor Lockwood and assistants. Five lectures and five laboratory periods per week.
Dairy Bacteriology. Professor Marshall. Two lectures and one two-hour laboratory period per week.
Animal Diseases and Stable Sanitation. Professor Paige. Two lectures per week.
Poultry Husbandry. Five lectures and one two-hour laboratory period per week.
Fruit Growing. Professor Sears. Three lectures and one two-hour laboratory period per week.
Market Gardening. Mr. Harris. Three lectures and two two-hour laboratory periods per week.
Floriculture. Professor Thayer and Mr. Whiting. Five lectures per week.
Horticultural Manufacture. Professor Chenoweth. Two lectures and two laboratory periods per week.
Farm Management. Assistant Professor Abell. Two lectures a week.
Farm Accounts. Assistant Professor Abell. Two two-hour laboratory periods per week.
Marketing. Professor Cance and assistants. Two lectures a week.
Agricultural Credit. Professor Cance and assistants. Two lectures a week.
Botany. Assistant Professor McLaughlin. Two lectures a week.
Entomology. Assistant Professor Regan. Three lectures per week.
Farm Structures. Assistant Professor Strahan. Two lectures and one two-hour laboratory period per week.
Farm Machinery. Professor Gunness. Two lectures and three two-hour laboratory periods a week.
Rural Sanitary Science and Hygiene. Professor Marshall. Two lectures per week.
Vocational Guidance. Miss Hamlin. One lecture per week.
Foods. Miss Skinner. One lecture and two two-hour laboratory periods per week.
Clothing. Department of Home Economics. One lecture and two two-hour laboratory periods per week.
The Business of the Household. Miss Skinner. Three class hours per week.
Home Care of the Sick. Miss Skinner. Three class hours per week.
Principles and Methods of Vocational Agricultural Teaching. Professor Hart. Five exercises per week.
Special Methods in Vocational Agricultural Teaching. Professor Welles. Five exercises a week.
Professional Improvement Problems. Mr. Heald. Five periods per week.

C. THE SUMMER SCHOOL.

In 1919 a plan of co-operation between the Massachusetts Agricultural College and the Division of Elementary and Normal Schools of the State Department of Education was begun. Twenty-five courses were offered in agriculture and horticulture, and nineteen courses in education.

The enrollment was the largest in the history of the college. The plan was so satisfactory that it was continued in the 1920 Summer School. More courses in agriculture, horticulture and education were offered. Three hundred and nineteen students were enrolled.

The following subjects were offered: —

Agriculture: —
- Soil fertility.
- Manures and fertilizers.
- Types and breeds.
- Feeding and management.
- Dairying.
- Poultry.
- Farm management.
- Farm accounts.
- Farm machinery and gas engines.
- Repair of farm equipment.

Horticulture: —
- Garden flowers.
- Indoor flower growing.
- Food Preservation I.
- Food Preservation II (two weeks).
- Fruit growing.
- Vegetable gardening.

Home life and practical arts: —
- Foods.
- Elementary dietetics.
- Clothing I.
- Clothing II (advanced).
- Business of the household.

Education: —
- Primary language.
- Primary reading.
- Arithmetic I (primary).
- Arithmetic II (intermediate).
- Method of teaching history in grammar grades.
- Training in the duties of citizenship.
- Methods in elementary schools.
- Methods in English for the intermediate and grammar grades.
- Design and practical arts.
- Oral English and parliamentary practice.
- Organized play and recreation.

Related subjects: —
- Insect life.
- Hygiene and sanitation.
- Marketing agricultural products.
- Plant diseases.
- Rural sociology.
- Agricultural opportunities for women.

Vocational agricultural teaching: —
- Principals and methods of teaching.
- Special methods in vocational agricultural teaching.
- Professional improvement problems.

In addition to the four weeks' school, a six weeks' course in agricultural education, from June 28 to August 6, was given.

The Two-year Course was continued for an eight weeks' term during the summer, from June 28 to August 28, to accommodate ex-service men in training under the Division of Rehabilitation of the Federal Board for Vocational Education.

D. ONE-YEAR VOCATIONAL COURSE IN POULTRY HUSBANDRY.

Purpose. — This course is designed for graduates of the agricultural vocational schools and others who wish to prepare themselves for practical poultry keeping, and can spend only one year at college.

Scope. — The work covers seven detailed courses in poultry husbandry, as well as short-course work in fruit growing, market gardening, animal husbandry, or other subjects that will be helpful to poultry raisers. In addition to classroom and laboratory exercises each student is required to put in from twenty-five to thirty hours per week at the plant in the care and management of poultry, for the purpose of becoming proficient in the various branches of the work.

Entrance Requirements. — Applicants must be at least eighteen years of age and have a good elementary education.

Fees. — There is no tuition for residents of Massachusetts, but a laboratory fee of $5 is required for both the fall and spring terms.

Note. — The course is limited to 16 students. The One-year Poultry Course begins in December and continues until the following December.

E. UNIT COURSES.

The Unit Courses were organized to provide instruction for men disabled in the military or naval service of the United States, who were unable on account of limited education to enter the Two-year course.

A student enters the agricultural Unit Courses if his previous education is not sufficient to permit of his taking up the work of the Two-year Course. The agricultural Unit Courses begin every month in the year except September. Each man may select, in addition to the English and mathematics that is required, two or three lines of work to which he will expect to devote most of his time.

In connection with the Unit Courses there is much actual practice on the farms, orchards, gardens, in the dairies, barns, shops and greenhouses, and with poultry, live stock and farm machinery. These courses are limited to students sent by the Federal Board for Vocational Education.

The following subjects are offered: —

Agronomy.
Animal husbandry.
Dairying.
General horticulture.
English.
Arithmetic.
Fruit growing.
Vegetable gardening.
Poultry.
Farm mechanics.
Floriculture.
General horticulture.

THE EXTENSION SERVICE

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The Extension Service of the Massachusetts Agricultural College is an organized effort to carry systematic and practical instruction to the thousands of people throughout the State who are unable, owing to various reasons, to take advantage of the regular courses offered at the college. It is in reality the "carrying of the college to the people of the State." Every department of the institution, in so far as the regular teaching and research work will permit, contributes what it can to this work. There is also a regular staff of extension workers whose business it is to present the instruction of the college to individuals and various educational organizations, such as extension schools, granges, Y. M. C. A.'s, churches, boards of trade, etc., throughout the State, in addition to giving county farm bureaus assistance in their project work. Extension work includes the following: extension courses at the college; home study courses; itinerant instruction, including lectures and lecture courses, exhibits, demonstrations and extension schools; extension work through the various departments of the college, in which the extension specialist is responsible to the head of the department for the technique of the work and to the director of the Extension Service for its accomplishment; co-operative work of various kinds with the United States Department of Agriculture; and extension work through county, district and local agents. Some of the ways in which this is being done are briefly described below.

CONFERENCES AT THE COLLEGE.

Meetings of the duration of one week or under are managed by the Extension Service, and include, in the winter, programs for special agricultural interests or organizations, and, in the summer, the big summer Farmers' Week.

THE WINTER COURSES. — These courses are arranged to meet the demand for a short course of instruction on agricultural subjects, requested by such interests as the State institutional managers and various live-stock, crops, tobacco, fruit and market-gardeners' associations. A sheep-shearing contest is also arranged for the sheep breeders' association. Instruction is presented by lectures, demonstrations and conferences. The college equipment is available for use, and the subject-matter may be selected or suggested by those expecting to attend. The work of the college faculty may be supplemented by lectures and demonstrations by eminent men and women from our own and other States. No fee is charged.

SUMMER FARMERS' WEEK. — The second summer Farmers' Week, held at the college July 26 to 30, 1920, was attended by 5,300 people who were able to inspect the college farms and orchard at the height of the growing season. Summer Farmers' Week was instituted to meet the demand for an opportunity to see the actual outdoor work of the college farm and experiment station, and to see the college teaching put into practice in the field. As the winter meetings of necessity are confined to indoor lectures and demonstrations, the summer Farmers' Week places the emphasis on outdoor work, and limits the program to one or two lectures a day. The greater part of the time is devoted to personally conducted field trips to all parts of the college property. Various agricultural organizations have field days at the college during the week, and every available facility for their entertainment is placed at their disposal. Farm bureaus, agricultural organizations and individual farmers co-operate in supplying requested information as to the probable subject-matter which visitors desire on the program. With the program for the week is furnished a detailed map of the college property, and, with the signs and guideposts which are numerously displayed to explain various features, the services of a guide are not required to see what is desired.

ANNUAL CONFERENCE OF COUNTY AGENTS. — In December of each year a one-week conference of county agents is held at the college. This is for the purpose of correlating the extension work throughout the State, and to enable the field workers to keep in up-to-the-minute touch with agricultural problems, methods and research as conducted in Massachusetts as well as other States in this particular section of the country. The next annual conference will be held during the second full week in December, 1920.

POULTRY CONVENTION. — The annual poultry convention, now included as one of the main events on the program of summer Farmers' Week, is the most important meeting in the State for the poultry public. Men of national reputation are secured for this occasion. In preparing the program, the wishes and needs of the poultry men and women are given first consideration, and topics of the most timely interest are listed for discussion by the best-informed authorities.

HOME STUDY COURSES. — The purpose of the home study courses is to furnish systematic instruction in those lines which will most benefit the general farmer, the dairyman, the fruit grower, the market-gardener, the poultryman, the teacher, the home maker, and all others who are interested in agricultural and country-life matters. It is the purpose to present up-to-date, accurate and concise information in such a manner and in such language that all who pursue the study may readily understand the work.

Courses offered. — A number of courses are in process of revision and several are being rewritten. During 1920 courses will be available as follows: —

1. Soils and Soil Fertility. Professor BEAUMONT.
2. Manures, Fertilizers and Soil Amendments. Professor BEAUMONT.
3. Field Crops. Professor JONES.
4. Farm Dairying. Professor LOCKWOOD.
5. Fruit Growing. Professors SEARS and VAN METER.
6. Vegetable Gardening: Part I, Market Gardening; Part II, Home Gardening. Prof. H. F. TOMPSON.
7. Farm Accounts. Professors FOORD and MACDOUGALL.
8. Entomology. Dr. REGAN.
9. Forestry. Professor GROSE.
10. Shade Tree Management. Professor OSMUN.
11. Plant Diseases. Professor OSMUN.
12. Poultry Husbandry. Professors GRAHAM and PAYNE.
13. Home Economics. Miss SAYLES.

Methods of conducting the Work. — The best known methods of conducting correspondence course teaching are employed. Certain courses are based entirely upon textbooks, others consist wholly of typewritten lectures, while others combine the two. If books are not required they are usually recommended.

The courses are designed primarily for the individual student, although experience has shown the advantages of the group method of home instruction. Prospective students should endeavor to find four or more others who will enroll in the same or other courses, so that a study class may be formed. Such a method has the advantage of instruction under the guidance of a leader, who is a member of the class. Furthermore, it is usually possible for the Extension Service to send a speaker to the class two or three times during the term to help the members of the group with their individual problems. The college library will also arrange for the loan of books to be used as text and reference reading.

Enrollment of Home Study Courses. — Students may enroll in the courses at any time between October 1 and June 1, and one year from the date of registration is allowed for the completion of each course.

Expenses of the Courses. — In order that none shall enroll except those who are interested and desire to pursue earnest study, a small fee is charged. This has been fixed at $2 for each course except where the courses are divided, and it has been found advisable to charge $2 for each of the parts in these instances. The fee is payable strictly in advance, at the time the enrollment card is sent. When textbooks are required the student purchases these.

LECTURES AND DEMONSTRATIONS. — The members of the faculty of the college are, when other duties will permit, available for lectures and demonstrations before granges, men's clubs, women's clubs, Y. M. C. A.'s, farmers' clubs, boards of trade and other organizations. Organizations arranging the lectures are asked to pay the traveling expenses of the lecturer, provided no admission fee is charged. When admission is charged the lecturer is entitled to a fee in addition to traveling expenses.

EXTENSION SCHOOLS. — Agricultural extension schools dealing with the production side of farming and with the problems of the farm home are offered to communities where there is the desire to have the college brought to the community. The college sends a corps of instructors and the necessary equipment to put on a program of instructional work in live-stock, crops, soils, fruits, market-gardening, poultry or farm management and home makers' courses for women. Communities desiring an extension school make a written request, agreeing to defray all local expenses, such as the rent, heating and lighting of a suitable hall, and the board of the instructors during the school. Information can be obtained by writing to the Extension Service of the Massachusetts Agricultural College.

EDUCATIONAL EXHIBITS AT FAIRS AND OTHER SHOWS. — The college coöperates with the managers of fairs, industrial expositions, corn shows, poultry shows, fruit shows and other exhibitions by making educational exhibits. Where practicable the exhibit is accompanied by lecturers and demonstrators.

EXTENSION WORK IN SPECIAL FIELDS.

EXTENSION WORK IN FRUIT GROWING. — This work includes lectures and demonstrations on laying out and planting orchards, pruning, spraying, thinning, grading, packing and marketing fruits. Demonstration orchards, new and renovations plots, are established in different sections of the State, under a co-operative agreement between the college and the owners of land. Extension schools in fruit growing and fruit grading and packing are arranged on request. Visits to farms for advisory work are made, and correspondence on orcharding subjects is invited.

Extension Work in Animal Husbandry. — The purpose of this work is primarily to acquaint the farmers of the State with improved methods of developing the live-stock industry of the State. This is done by assistance rendered communities of farmers who wish to organize live-stock centers, and also by co-operating with other active educational organizations already established.

Upon request, and where conditions favor the organization of county live-stock clubs, cow testing associations and bull associations, assistance is provided.

Live-stock feeding, breeding and management demonstrations are established in different sections of the State under co-operative agreement between the college and the owners of live stock. Extension schools, involving the selection, housing, general management and marketing of live stock, are arranged on request. Advisory trips to farms are made, and correspondence on subjects relating to live stock is invited.

Extension Work in Dairying. — This includes lectures and demonstrations on the handling and care of milk, cream, butter and cheese; Babcock testing, dairy utensils and dairy manufactures. Educational campaigns may be arranged in different communities, seeking to educate producers, dealers and consumers as to the production and distribution of clean, safe milk. Through correspondence and personal visits advice is given —

1. To help the improvement of the quality of dairy products.
2. To help in the problem of more economical handling and manufacturing.
3. To help stimulate a larger and continued use of dairy products.

Extension Work in Poultry Husbandry. — In addition to such general activities as lectures, demonstrations, extension schools, exhibits, conferences, farm visits, bulletins and plans for developing poultry plants, the poultry extension practice is to emphasize, each year, two or three urgent needs of the industry in State-wide campaigns aiming to reach all poultrymen of the State.

In co-operation with the several county farm bureaus definite county projects and community programs are arranged; and co-operative work is undertaken with many local poultry associations. Service is also rendered in the diagnosis and control of poultry diseases.

The annual poultry convention on the campus is attended by hundreds of poultrymen.

Extension Work in Sheep Husbandry. — The extension work in sheep husbandry, started in 1917 in co-operation with the United States Department of Agriculture, was temporarily discontinued upon the resignation of the sheep specialist in October, 1920.

Extension Work in Farm Management, Field Studies and Demonstrations. — This is carried on co-operatively between the college and the office of farm management of the United States Department of Agriculture at Washington. The work consists of a study of farm conditions, followed by suggestions for handling farm management problems, often involving an adjustment of the different enterprises, such as dairy, orchard or field crops, so as to give economical use of labor and material, and make a profitable business. Specific advice is given upon the planning of farms and farm buildings, the proper farm equipment and the keeping of farm accounts.

Extension Work in Soils and Crops. — The subject-matter of this work considers the economical production of crops and the economical maintenance of soil productivity in Massachusetts. The crops adapted to Massachusetts conditions, their relative place in agriculture, their culture, fertilization, etc., are considered.

The work done can be grouped under the following main headings: —

1. Project work, county farm bureaus: —

(*a*) Assistance in soil and crop problems and in demonstration work.

(*b*) Assistance at meetings and in work with individual farmers and organizations.

2. Correspondence. Conducting correspondence courses and answering inquiries sent to the college.

3. Lectures and demonstrations at meetings and extension schools.

4. Preparation of exhibit material.

5. Preparation of short articles dealing with timely soil and crop problems.

Extension Work in Home Economics. — This work includes lectures and demonstrations on subjects pertaining to homemaking. This year special emphasis will be placed on clothing, household management and right food for the family. Instruction is carried on by means of a series of lessons given to groups who are housekeepers and leaders as well. All work is done in coöperation with the county home demonstration agents.

Junior Extension Work. — This is an organized effort to promote among young people between the ages of ten and nineteen years the study of agriculture and home economics in the home. The work organized by the United States Department of Agriculture is carried on by the college in coöperation with county farm bureaus or improvement leagues. As far as possible the young people are organized into groups or clubs; where this is impossible the work is done with the individual. An endeavor is made to obtain some one in each community to act as a local leader of the club. Many school superintendents find it one means of stimulating enthusiasm for outdoor life among their pupils. Throughout the State teachers of rural schools use it to tie up the school and home life. City school teachers have found it helpful in finding the rural-minded pupils living under urban conditions. Exhibits held locally or at county and State fairs do much to arouse a wholesome spirit of competition among the members. The State Department of Agriculture and several private organizations appropriate money to further the work. The work is usually introduced by conferences with individuals interested, and lectures before any organization interested in young people and desiring to see the work carried on in any community.

Library Extension Work. — This consists principally of loaning to the libraries of the Commonwealth general collections of the latest and best books and bulletins on agriculture and home economics. Smaller collections or package libraries on special subjects, such as fruit harvesting and marketing, dairying, poultry houses, beekeeping, home economics, country schools and other topics, are also sent out.

This material is loaned for a period of eight weeks, subject to renewal when possible. All transportation charges for shipments to or returned from borrowing libraries are paid by the Extension Service. The college library also supplies lists of books on various subjects, and also information about books on agriculture, home economics and related subjects.

LOCAL COMMUNITY ORGANIZATION. — Work under this project is temporarily suspended, leave of absence having been granted to the project leader to do some special work with the National Red Cross.

EXTENSION WORK IN AGRICULTURAL ECONOMICS. — Work in this field has been developing along six lines all connected with commercial agriculture, emphasizing the production of value or money returns rather than volume of agricultural products. Much of this work is conducted in direct co-operation with the United States Department of Agriculture.

(*a*) *Rural Credit.* — Sources and means of providing credit for buying or financing farms, purchasing supplies or storing and distributing farm crops.

(*b*) Better methods of marketing, grading and distributing farm crops.

(*c*) Assistance in organizing co-operative buying and selling associations. Helping to establish producers' city and country milk plants and co-operative tobacco packing plants.

(*d*) Assistance in establishing farmers' markets, both wholesale and retail, in cities, to furnish an outlet for perishable local produce and to provide a better market for consumers.

(*e*) *Direct Marketing.* — The college was the first agency to bring about direct connection between farmers and industrial plants for trading in potatoes, onions, etc., from farm to consumer.

(*f*) *Market News Survey.* — In co-operation with the farm bureaus and United States Bureau of Markets, a plan has been perfected whereby a daily market report of wholesale and retail prices of local produce is being furnished by the farm bureaus to a number of daily papers. These reports, made in retail units, have been very helpful both to producers and to city consumers.

FOOD PRESERVATION. — On account of the demands for instruction in food preservation, particularly preservation of fruits and vegetables, much attention was given to this work during the year, the work being carried on chiefly through training local leaders to handle the work. Special attention is given to the manufacture of fruit by-products, to home and farm storage and to the operation of preservation kitchens. The project is carried out through demonstrations, extension schools, farm visits and correspondence.

FARM BUREAU WORK. — Co-operative extension work is carried on in counties by means of farm bureaus. Agents in agriculture, homemaking and junior work are co-operatively employed by the Massachusetts Agricultural College, the United States Department of Agriculture and the county. The residents of the county are consulted in community groups as to the work to be done, and then all assistance which is possible to be secured from the United States Department of Agriculture, the college and the county is brought in to complete successfully the work planned. The work receives its financial support from public funds which are secured from the above co-operating parties and the county commissioners. Private funds in the form of memberships and contributions are also received. The administration of the work in each county is vested in a board of ten trustees who are appointed by the county commissioners, co-operating with representatives of the Extension Service at the College.

ADVISORY WORK WITH INSTITUTIONS AND INDIVIDUALS. — Special effort is made to comply with as many of the requests of the State institutions and individuals who ask for advice on farm problems as possible. The force of instructors available for this work is at present insufficient to take care of all the demands. Special trips, including visits to a number of the various State institutions, are occasionally made by a group of specialists.

Publications of the Extension Service. — In addition to the regular circulars and bulletins which announce the various short courses and lines of work mentioned, publications giving timely information on agricultural subjects are issued. Large numbers of helpful circulars and bulletins are annually distributed. A series of bulletins especially for the farm woman is one feature of this work. Reports of the work of the Extension Service, farm account blanks, boys' and girls' club circulars, lists of books, and so forth, may be had upon request.

Co-operation with Other Organizations. — The aim of the Extension Service is to co-operate with existing organizations so far as possible. It is therefore glad to work with local organizations, and welcomes suggestions from town officers, local granges, farmers' clubs, women's clubs, Y. M. C. A.'s, Y. W. C. A.'s, boards of trade, village improvement societies, teachers, clergymen, librarians and others interested in agriculture and country life, as to the needs and methods best adapted to the meeting of these needs.

Information by Correspondence. — Besides the activities mentioned, hundreds are helped through personal visits to farms, and still larger numbers through letters of inquiry, which always receive the most careful attention from every department of the institution.

Pamphlets and bulletins are sent free to all who apply for them, and any who desire such help as has been mentioned should address the Director of the Extension Service, Massachusetts Agricultural College, Amherst, Mass.

GENERAL INFORMATION

GENERAL INFORMATION.

A. FINANCIAL AND ADMINISTRATIVE.

Student Expenses.

TUITION.[1] — Tuition is free to residents of Massachusetts. Students who are not residents of Massachusetts are charged a tuition fee of $60 a year. The tuition charged persons not citizens of the United States is $120 a year. Students entering from Massachusetts are required to file with the president a statement signed by either town or city clerk stating that the applicant's father is a legal resident of Massachusetts; a similar statement is required of those entering from other States.

All students entering the college for the first time as undergraduates or two year students are charged a matriculation fee of $5, which in event of a student leaving the institution shall, if all bills due the college are paid, be remitted, or which shall upon graduation be considered as payment for the diploma.

DORMITORIES AND BOARD. — The college has dormitory accommodations for about 62 men students. The rooms in the dormitories are occupied by the upper classmen, hence new students find it necessary to room in private houses. The rooms in the college dormitories are unfurnished; for the most part they are arranged in suites of three, — one study room and two bedrooms. These rooms are heated by steam and lighted by electricity; they are cared for by students occupying them. The dormitory rent for each person varies from $39 to $66 a year. The rent for furnished rooms in private houses ranges from $1 to $4 a week for each occupant. Correspondence in regard to rooms should be addressed to the dean of the college.

Board may be obtained at the college dining hall. At present, the price of board there is $7 a week.

Expenses.

The necessary college expenses are estimated as follows: —

Tuition: citizens of Massachusetts, free; other citizens of the United States, $60 a year; foreigners, $120 a year.

	Low.	High.
Matriculation fee, first year,	$5 00	$5 00
Room in college dormitories or in private houses,	39 00	110 00
Board, $7 per week,	252 00	252 00
Laundry, 50 to 85 cents a week,	18 00	30 00
Laboratory fees,	5 00	25 00
Books, stationery and miscellaneous items,	31 00	53 00
	$350 00	$475 00

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[1] This statement applies to those registering as regular or two-year students.

Other Expenses. — Prospective students should understand that the above estimates cover expenses which may be called strictly college expenses, and that there are other financial obligations voluntarily placed upon students which they should expect to meet. Chief among these are class assessments and taxes levied for maintenance of various organizations, such as the Social Union, Athletic Association, weekly publications, etc. Such expenses vary from $15 to $30 a year. Additional financial responsibility is also assumed by students joining a fraternity or entering into other social activities of the college. Students rooming in college dormitories are obliged to equip their own rooms with furniture. The college assumes no responsibility in regard to the safe keeping of student property either during the college term or vacations, except under such special arrangement as may be made with the treasurer. Besides the amount necessary for clothes and traveling, the economical student will probably spend between $325 and $450 per year.

Initial Charges.

At the opening of the college year, before students are registered in their classes, the following charges are payable at the treasurer's office: —

	Freshmen.	Sophomores.	Juniors and Seniors.
Matriculation fee, ...	$5 00	-	-
Board (if at college dining hall) four weeks in advance,	28 00	$28 00	$28 00
Assessment for support of Social Union, . . .	1 50	1 50	1 50
Laboratory fees, ...	5 00	5 00	2 00-10 00
Room rent (if in college dormitory), ...	-	-	12 00-20 00
Student tax for support of athletics,[1] . . .	4 00	4 00	4 00
Student tax for support of nonathletic activities,[1] .	2 50	2 50	2 50

[1] While this is not essentially a college charge, the treasurer of the college acts as collector for the student activity, and all students are expected to make the payment as indicated. The subscription price of the "Collegian" is fixed by the managers; the amount of athletic tax by vote of the student body.

Laboratory Fees.

The principles observed in establishing laboratory fees are the requirement that students pay for those materials actually used which cannot be supplied by the individual, and that the laboratory fees include a charge sufficient to guard against wanton waste and breakage. Fees may be established for any course without previous announcement. At present, the fees charged are as follows: —

Agronomy: —	Per Term.
Course 1, 1, ...	$1 50
Course 27, 3, ...	2 00
Course 50, 1, ...	2 50
Course 51, 3, ...	2 50
Course 75, 1, ...	2 00
Course 77, 2, ...	2 50
Course 78, 3, ...	2 50

	Per Term.
Animal husbandry: —	
Course 1,	$1 00
Course 25, 1,	1 50
Course 26, 2,	1 50
Course 75, 1,	1 50
Course 78, 2,	1 00
Dairying: —	
Course 50, 1,	2 50
Course 51, 3,	2 50
Course 75, 2,	2 00
Course 76, 3,	3 00
Course 77, 1,	2 50
Farm management: —	
Course 75, 1,	1 50
Course 76, 1,	1 50
Poultry husbandry: —	
Course 51, 1,	2 50
Course 53, 3,	3 00
Course 55, 3,	2 50
Course 76, 1,	2 00
Course 77, 1,	2 00
Rural engineering: —	
Course 25, 1,	1 50
Course 26, 2,	1 50
Course 75, 1,	1 50
Course 77, 2,	1 50
Course 78, 3,	1 50
Floriculture: —	
Course 50, 1,	2 50
Course 51, 2,	2 50
Course 52, 3,	2 50
Course 53, 1,	2 50
Course 75, 1,	2 00
Course 76, 2,	2 00
Course 77, 2,	2 50
Course 78, 3,	2 50
Forestry: —	
Course 50, 1,	2 00
Course 51, 2,	3 00
Course 75, 1,	4 00
Landscape gardening: —	
Course 50, 1,	2 50
Course 51, 2,	2 50
Course 52, 3,	2 50
Course 76, 2,	3 00
Course 77, 3,	3 00
Course 80, 1,	3 00
Course 81, 2,	3 00
Course 82, 3,	3 00
Vegetable gardening: —	
Course 50, 3,	2 00
Course 51,	2 00
Course 52,	2 00
Course 53,	2 00
Course 75, 1,	3 00
Course 76, 2,	2 00

	Per Term.
Pomology: —	
Course 75, 1,	$4 00
Course 76, 2,	4 00
Drawing: —	
Course 25, 1,	3 00
Course 26, 2,	3 00
Course 27, 3,	3 00
Botany: —	
Course 3, 3,	1 50
Course 25, 1,	1 50
Course 26, 2,	1 50
Course 50, 1,	2 00
Course 51, 2,	2 00
Course 52, 1,	2 00
Course 53, 2,	2 00
Course 54, 3,	2 00
Course 55, 1,	3 00
Course 56, 2,	3 00
Course 75, 1,	3 00
Course 76, 2,	3 00
Course 77, 3,	3 00
Course 78, 1,	3 00
Course 79, 2,	3 00
Course 80, 3,	3 00
Course 82, 2,	3 00
Course 83, 3,	3 00
Entomology: —	
Course 50, 1,	1 00
Course 51, 2,	1 00
Course 53, 1,	1 00
Course 54, 2,	1 00
Course 55, 3,	1 00
Course 75, 3,	2 00
Course 76, 1,	3 00
Course 77, 2,	3 00
Course 78, 3,	3 00
Chemistry:[1] —	
Course 1, 1,	3 00
Course 2, 2,	3 00
Course 3, 3,	3 00
Course 4, 1,	3 00
Course 5, 2,	3 00
Course 6, 3,	3 00
Course 25, 1,	4 00
Course 26, 2,	4 00
Course 27, 3,	5 00
Course 30, 3,	4 00
Course 51, 1,	5 00
Course 52, 2,	5 00
Course 62, 3,	5 00
Course 65, 3,	4 00
Course 76, 1,	5 00
Course 77, 2,	5 00
Course 80, 1,	4 00
Course 90, 2,	5 00

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[1] An additional deposit of $1 for Courses 1 to 6, inclusive, and $2 for Courses 25 to 95, will be required to cover individual breakage. In case the laboratory breakage does not equal the deposit, the balance will be refunded.

Chemistry — *Concluded.*	Per Term.
Course 91, 3,	$5 00
Course 92, 2,	5 00
Course 93, 3,	5 00
Course 94, 2,	5 00
Course 95, 3,	5 00
Mathematics and engineering: —	
Course 27, 3,	1 50
Course 78, 3,	1 50
Microbiology: —	
Course 1,	3 00
Course 3,	2 00
Course 50, 1, 2 and 3,	5 00
Course 51, 2 and 3,	5 00
Course 52, 3,	5 00
Course 75, 2,	5 00
Course 76, 3,	5 00
Course 80, 2,	5 00
Course 81, 1,	5 00
Course 82, 1,	5 00
Course 83, 1,	5 00
Physics: —	
Course 27, 3,	3 00
Course 50, 1,	3 00
Course 51, 2,	3 00
Course 52, 3,	3 00
Veterinary science: —	
Course 78, 1,	2 00
Course 79, 2,	2 00
Course 80, 3,	2 00
Course 85, 1,	2 00
Course 86, 2,	2 00
Course 87, 3,	2 00
Zoölogy and geology: —	
Course 25, 1,	3 00
Course Zoölogy 27, 3,	3 00
Course 50, 1,	3 00
Course 51, 2,	4 00
Course 52, 3,	4 00
Course 53, 1,	4 00
Course 54, 2,	3 00
Course 55, 3,	3 00
Course 58,	2 00
Course 75, 1,	3 00
Course 76, 2,	3 00
Course 77, 3,	3 00
Course 78, 2,	2 00
Course 79, 3,	2 00
Rural journalism: —	
Course 53, 1,	2 00
Course 54, 2,	2 00
Course 55, 3,	2 00
Course 77, 1,	2 00
Course 78, 2,	2 00
Course 79, 3,	2 00
Course 80, 1,	2 00
Course 81, 2,	2 00
Course 82, 3,	2 00

	Per Term.
Music (each course),	$3 00
Rural home life: —	
Courses 25, 26, 27,	1 50
Courses 50, 51, 52,	4 00

Rooms.

Students are expected, as far as possible, to occupy rooms in the college dormitories. Students who do not live in the college dormitories must secure rooms approved by the college. The assignment of rooms, and the general supervision of the housing of students, is in charge of the dean. The inspection of student quarters is in charge of the commandant. At the end of each college year all unoccupied rooms will be thrown open for selection, and will be assigned to students according to classes.

Living Accommodations for Women Students.

Women students attending the college live in a dormitory provided for them, and take their meals at Draper Hall, which is located a short distance from the women's dormitory. The women's dormitory accommodates 98 girls, and is furnished.

Student Aid.

Self Help. — Many students are obliged to find work of some sort to earn their way through college. A few men have met their entire expenses in this manner, many more have paid a large part of their expenses, and many have earned a small proportion of the cost of their college education; but the college recommends that no new student enter without having at least $150 and preferably $250 with which to pay his way until he can establish himself in some regular work. The college does not encourage students to enter without money in the expectation of earning their way entirely. The ordinary student will find it better either to work and accumulate money before coming to college, or to take more than four years in completing his college course, or, instead, to borrow money sufficient to carry him through. No student should undertake work that interferes with his studies, and students should understand that, owing to the large number of applications for employment, no one man can receive a large amount of work at the college. A number of students find opportunities for earning money without depending upon the college to furnish them with work.

So far as possible needy students will be employed in some department of the college. The divisions of agriculture and horticulture usually afford the most work, although there are several permanent janitorships available for students, and twenty or more students are employed at the dining hall.

Application for student labor should be made directly to Kenyon L. Butterfield, president of the college. Applicants are required to present statements from parent or guardian and from a public official or other responsible person of the town or city in which they reside, explaining the necessity of the applicant's need of assistance. Students whose deportment or class work is not satisfactory are not likely to be continued in student labor. The most desirable and responsible positions are naturally assigned to those needy students who have been in the institution longest and who have demonstrated their need and ability. Students, therefore, may find it rather difficult to obtain all the work they desire during their freshman year; as a matter of fact, however, any student who is capable of doing a variety of things, and who is a competent workman, usually finds little difficulty in obtaining all the work that he can do from the outset.

Special Notice to Needy Students. — In the last few years the demand for paid labor on the part of new students has far exceeded the amount of employment that the college can offer. The college cannot promise work to any student, particularly to freshmen; it accordingly urges prospective students who are dependent entirely upon their own efforts not to undertake the course before they have earned enough money to carry them through, or nearly through, the first year.

Student Accounts.

The following rules are enforced concerning student accounts: —

No student will be allowed to graduate until all bills due the institution from him are paid.

College charges, such as room rent, laboratory fees and tuition, must be paid in advance, at the beginning of each term. This rule is strictly adhered to, and no student will be allowed to complete his registration until such payments are made.

Every student boarding at Draper Hall is required to pay at the beginning of each term at least one month's board in advance; and no student will be allowed to continue to board at Draper Hall if at any time during the term he is more than one week in arrears in his payment for board.

All money due for student labor shall at the discretion of the treasurer of the college be applied on account toward any bills that a student may owe to the institution.

Student Relations.

The customary high standard of college men in honor, manliness, self-respect and consideration for the rights of others constitutes the standards of student deportment.

Any student known to be guilty of dishonest conduct or practice must be reported by the instructor to the president for discipline.

The privileges of the college may be withdrawn from any student at any time, if such action is deemed advisable.

It should be understood that the college, acting through its president or any administrative officer designated by him, distinctly reserves the right not only to suspend or dismiss students, but also to name conditions under which students may remain in the institution. For example, if a student is not doing creditable work he may not only be disciplined but he may also be required to meet certain prescribed conditions in respect to his studies, even though under the foregoing rules his status as a student be not affected. The same provision applies equally to the matter of absences ("cuts"). According to the rules a student is allowed a certain percentage of absences from class and other exercises. This permission, which implies a privilege and not a right, may be withdrawn at any time for any cause.

Similarly, also, it applies to participation in student activities. Though this will ordinarily be governed by the rules as already laid down, yet, if in the judgment of the college authorities a student is neglecting his work on account of these activities, the privilege of participating in them may be withdrawn for such time as is considered necessary. Moreover, it may be withdrawn as a punishment for misconduct. Prospective students or their parents may, upon application, obtain a copy of the faculty rules governing student relations to the college.

Infirmary.

The college maintains an infirmary for the care of sick or injured students. The buildings now available for this purpose are quite inadequate for the needs of the institution, and it is hoped that in the near future other buildings of this kind may be erected and the general equipment somewhat amplified. At present two small buildings, built especially for hospital purposes, are used for the infirmary.

The following statement outlines the plan followed in the management of the infirmary with respect to students: —

MANAGEMENT OF THE INFIRMARY.

Supervision.

1. The infirmary is under the *general supervision* of Prof. Charles E. Marshall who is designated as Supervisor of the Infirmary. Miss Grace Charman the resident nurse, with Miss Marguerite Davis as assistant resident nurse, is in *immediate* charge of the infirmary.

Use of Infirmary.

2. Students are urged to go to the infirmary at any time that they are in need of the services rendered by the resident nurse or by a town physician. Inasmuch as the physical director gives special attention to all student diseases, it is to be expected that the majority of the students will go to the infirmary at his suggestion. This understanding, however, should in no way deter students from going to the infirmary voluntarily at any time.

General Health.

3. Students are urged to consult the physical director or the resident nurse immediately when signs of physical disorder appear. Severe attacks of cold or other forms of illness can usually be avoided if treatment is administered in the incipient stage. The purpose of the infirmary is to help maintain the general good health of the students, as well as to furnish a suitable place for professional attention in cases of severe illness or accident.

General Fee.

4. The infirmary fee will be at the rate of $2 a day, and will be charged when one or more meals are obtained at the infirmary, or when the student remains at the infirmary for one or more nights. A nominal charge will be made to out patients for miscellaneous treatment of a minor character.

Additional Expenses.

5. In addition to the fee charged, as specified in paragraph 4, the following additional expenses will be charged to the patient: —

(*a*) *Nurses.* — In case a special nurse is required for the proper care of an individual, the services and board of this nurse will be paid by the patient. Such a nurse will be under the general supervision of the resident nurse.

(*b*) *Professional Service.* — If a student requires medical attention by a physician, he will be required to select his physician and become responsible for fees charged by the physician.

(*c*) *Supplies.* — Special medical supplies prescribed by a physician or nurse will be charged to the patient.

(*d*) *Laundry.* — Expense for personal laundry incurred by students while in the infirmary will be charged to the individual student.

B. COLLEGE ACTIVITIES.

General Exercises.

Chapel exercises are held two mornings each week. On Wednesday an afternoon assembly is held, to which some prominent layman or professional man is invited to speak. The object of these assemblies is to bring to the students discussions of topics of present-day interest. A special chapel service on Sunday is usually held during the winter months. Students are required to attend these general exercises, although the president is authorized to excuse from chapel any student who may object to attendance thereon because of his religious scruples, provided his request for excuse therefrom is endorsed by his parent or guardian.

Student Activities.

A large number of student organizations furnish opportunity to students for work and leadership.

The Massachusetts Agricultural College Social Union was established about ten years ago. All students become members of the union by paying a small fee. The union is designed to become the center of student interests. In North College it has a trophy room and a large lounging room for music, reading and study; in the basement of this building there is also a game room for pool and billiards. In the fall and winter months the union gives a series of entertainments, free to students and faculty.

The College Senate is composed of representatives of the junior and senior classes. This body serves as a general director of undergraduate conduct, and represents before the faculty the interests of the student body.

The Young Men's Christian Association is active both socially and religiously. A Catholic club has also been organized.

The musical organizations include an orchestra, a mandolin club and a glee club. These furnish music for college meetings, and occasionally give concerts at the college and at other places. A military band is maintained as part of the cadet corps.

A dramatic club has been organized, and each year presents a play.

The Public Speaking Council represents the students' interest in debate and oratory.

The Athletic Association represents in the college the interests of football, baseball, track, hockey and basket ball.

A rifle club has been organized for a few years. Teams representing this club have repeatedly won the intercollegiate championship of the country, both in indoor and outdoor contests.

The college publications are the "Massachusetts Collegian" published weekly by the student body, and the "Index," published annually by the members of the junior class.

The Stockbridge Club is an organization of students especially interested in practical agriculture and horticulture. Regular meetings are addressed by outside speakers, and members present papers and engage in discussions.

Clubs also exist in the Departments of French, Entomology, Floriculture, Landscape Gardening, Zoölogy and Agricultural Economics.

There has recently been organized a Collegiate Country Life Club, the membership of which is composed of faculty and students who are particularly interested in the study of country life problems.

A nonathletics student activities board, composed of alumni, faculty and students, has charge of the finances, schedules, etc., of the musical clubs, dramatic club and student publications.

C. ACADEMIC AND DEPARTMENTAL.

Degrees.

Those who complete a four-year course receive the degree of bachelor of science. The fee for graduation from the college is $5.

Graduate students who complete the assigned courses will receive the degree of master of science upon the payment of a fee of $10. Credit may sometimes be allowed towards this degree for teaching or other advanced work done in some department of the college.

Graduate students who complete the required three-year course of study, and present a satisfactory thesis, will be granted the degree of doctor of philosophy.

Those to whom degrees are awarded must present themselves in person at commencement to receive them. No honorary degrees are conferred.

The honorary fraternity of Phi Kappa Phi has a chapter at the agricultural college. Students are elected to membership to this fraternity on the basis of scholarship. Elections are made from the highest tenth of the senior class who have attained an average grade of at least 85 per cent during their college course.

Prizes.

Prizes are given annually in several departments for excellence in study or for other special achievement. Prizes offered in 1920 were: —

AGRICULTURE. — The Grinnell prizes, given by Hon. William Claflin of Boston in honor of George B. Grinnell, Esq., of New York, for excellence in theoretical and practical agriculture. Three prizes, $25, $15, $10. The contest is open to those senior students whose record on the registrar's books shows an average standing of 80 or above for the technical work taken in the Divisions of Agriculture and Horticulture during the junior and senior years.

Botany. — The Hills prizes, given by Henry F. Hills of Amherst, amount to $35 annually. Competition is open to members of the senior, junior and sophomore classes as follows: for the best herbarium, $20; for the second best herbarium, $15. No collection deemed unworthy of a prize will be considered.

Public Speaking. — The Burnham prizes are awarded as follows: to the students delivering the best and second best declamations in the Burnham contest, $15 and $10, respectively. The preliminary contests in declamation are open, under certain restrictions, to freshmen and sophomores.

The Flint prizes are awarded as follows: to the students delivering the best and second best orations in the Flint contest, a gold medal and $30 and $15, respectively. The preliminary contests in oratory are open, under certain restrictions, to all regular students.

The prizes in debate are awarded as follows: to each of the three students ranking highest in the annual debating contest, a gold medal and $15. The preliminary contests in debate are open, under certain restrictions, to all regular students.

Awards and Prizes, 1920.

Grinnell Prizes. — The Grinnell prizes, given by the Hon. William Claflin of Boston in honor of George B. Grinnell, Esq., of New York, to those members of the senior class who pass the best, second best and third best examinations, oral and written, in theoretical and practical agriculture, were awarded as follows: —

First prize, $25, Clinton J. Daggett.
Second prize, $15, George B. Woodward.
Third prize, $10, Ralph W. Hurlburt.

Public Speaking. — The Burnham prizes were awarded to the students delivering the best and second best declamations, as follows: —

First prize, $15, Harry A. Erysian, 1922.
Second prize, $10, Payson T. Newton, 1923.

Debating Prizes. — Debating prizes were awarded to the students making the best and second best presentations at the interclass debate, as follows: —

First prize, $15, Robert F. Martin, 1923.
Second prize, $10, Willis Tanner, 1922.

Flint Prizes. — The Flint prizes were awarded to the students delivering the best and second best orations, as follows: —

First prize, $20, Harry A. Erysian, 1922.
Second prize, $15, John A. Crawford, 1920.

Hills Prize. — A prize of $20 for the best herbarium was awarded to Otto Degener, 1922.

Military Honors. — Henry E. Lyons, Cadet officer, was granted the military diploma, was recommended for appointment in the Officers' Reserve Corps, United States Army, and was reported to the Adjutant-General of the Commonwealth of Massachusetts as being qualified for a commission in the National Guard.

State Teacher's Certificate. — The following persons, having fulfilled the requirements for a Massachusetts State teacher's certificate, were recommended for the same to the State Board of Education by the Dean and the Department of Agricultural Education: —

Daniel W. Belcher.
John A. Crawford.
Herbert M. Emery.
Arthur L. Frellick.
James J. Window.

Southern Alumni Baseball Cup. — The Southern Alumni baseball cup was awarded to Herbert L. Collins, 1922, the best all-round ball player during the season of 1920.

DEGREES CONFERRED AND ROLL OF STUDENTS

DEGREES CONFERRED — 1920.

MASTER OF SCIENCE (M.Sc.).

Prince, Arthur Leslie, A.B., Clark College,	Webster.
Purrington, James Alson, B.S.. New Hampshire College of Agriculture and the Mechanic Arts,	Hopkinton, N. H.

BACHELOR OF SCIENCE (B.Sc.).

Apsey, George Wills, Jr.,	Winchester.
Babbitt, George King, as of the class of 1918,	Bridgewater, Conn.
Bacon, Milo Roderick,	Leominster.
Baker, Henry Raymond, as of the class of 1918,	Amherst.
Baker, William Alphonso, as of the class of 1919,	Melrose.
Ball, Harry Abraham,	Bridgewater.
Batchelder, Stewart Putnam, as of the class of 1919,	North Reading.
Beauregard, Winfield Scott,	Framingham.
Belcher, Daniel Webster,	North Easton.
Berman, Harry,	Holyoke.
Binks, Frank Joseph, as of the class of 1918,	Maynard.
Boardman, Charles Meade,	Amherst.
Boyce, Alan Freeman, as of the class of 1919,	Melrose.
Buffum, Eliot Mansfield,	Waban.
Burns, Allan Melville, Jr.,	Taunton.
Burton, Lee Williams, as of the class of 1919,	Plainville.
Campbell, George Murray,	Baltimore, Md.
Card, Ralph Hunter,	Somerville.
Carleton, John Foxcroft,	East Sandwich.
Cassidy, Morton Harding,	East Boston.
Chambers, Roger James, as of the class of 1918,	Dorchester.
Chase, Malcolm Willis,	Amesbury.
Clapp, Augustus Warren, as of the class of 1919,	East Braintree.
Clarridge, Fred William,	Milford.
Clough, Alfred Arnold,	Wollaston.
Cole, Frederick Eugene, Jr.,	South Portland, Me.
Crafts, Gordon Burnham,	Manchester.
Crawford, John Alexander,	Allston.
Crowe, Charles, as of the class of 1919,	Norwich, Conn.
Daggett, Clinton Jones,	Albany, N. Y.
Delahunt, John Kersey,	Boston.
Derick, Glendon Robert,	Clinton.
Dewing, Warren Montague,	Kingston.
Doucette, Charles Felix,	Melrose.
Dowd, William Lawrence, as of the class of 1918,	Amherst.
Earley, Marion Edith,	Redlands, Cal.
Emery, Herbert Martin,	Newburyport.
Faneuf, Leo Joseph, as of the class of 1918,	West Warren.
Fellows, Harold Carter, as of the class of 1918,	Peabody.
Frellick, Arthur Lester, as of the class of 1918,	Everett.
Fuller, Camille Baldwin, as of the class of 1918,	Quincy.
Gifford, Flavel Mayhew, as of the class of 1918,	West Tisbury.
Glavin, William Francis, as of the class of 1919,	Wenham.
Goodridge, George Lucien, as of the class of 1918,	Melrose.

Goodwin, William Irving, as of the class of 1918,	Bradford.
Gordon, Frederick George, as of the class of 1918,	Plymouth.
Graff, Leland Sprague,	Newton Center.
Graves, Carlisle Ferrin,	Stamford, Conn.
Grayson, Forrest, as of the class of 1918,	Milford.
Green, Lynn,	Schenevus, N. Y.
Hamlin, Hazen Wolcott,	North Amherst.
Harrington, Harold Leon,	Lunenburg.
Harvey, Ebenezer Erskine,	Washington, D. C.
Hawley, Robert Dorman, as of the class of 1918,	Springfield.
Hill, John Farren,	Egypt.
Holloway, John William,	Taunton.
Holmes, Robert Palmer, as of the class of 1918,	Agawam.
Horne, Robert Sanderson,	Derry Village, N. H.
Howard, Arthur Merchant, as of the class of 1918,	Pittsfield.
Howe, Albert Edward, as of the class of 1918,	Needham.
Hurlburt, Ralph Walter, as of the class of 1918,	Ashley Falls.
Jakeman, Brooks Franklin,	Wakefield.
Johnson, Lawrence Wilhelm,	Avon.
Littlefield, John Edwin,	West Lynn.
Lothrop, Earle Daniel,	West Bridgewater.
Luce, William Alan,	West Boylston.
Lyons, Henry Egmont,	Cambridge.
MacLeod, Guy Franklin,	Lowell.
Maginnis, John Joseph, as of the class of 1918,	Lawrence.
Maples, James Comly,	Port Chester, N. Y.
Marshall, Max Skidmore, as of the class of 1918,	Amherst.
Mather, Fred, as of the class of 1917,	Amherst.
Meserve, Albert Wadsworth,	Framingham.
Millard, Helen Stanley,	Great Barrington.
Mitchell, Theodore Bertis, as of the class of 1918,	Needham.
Morse, Maurice, as of the class of 1919,	Dorchester.
Moynihan, Patrick Joseph, as of the class of 1918,	Holyoke.
Novitski, Joseph Francis,	Amherst.
Oertel, August Leonard, as of the class of 1918,	South Hadley Falls.
Peckham, William Harold,	Newport, R. I.
Perry, Errol Clinton, as of the class of 1919,	Acushnet.
Pike, Chester Arthur,	Springfield.
Prée, Karl Julius, as of the class of 1919,	Brookline.
Quadland, Howard Preston,	North Adams.
Readio, Philip Adna,	Florence.
Redding, George Kenneth,	Melrose.
Roberts, Mark Anthony, as of the class of 1919,	Dorchester.
Robertson, William Fenton,	Framingham.
Sanborn, Joseph Raymond,	North Amherst.
Sanderson, Ralph Hemenway,	Waltham.
Sawyer, Wesley Stevens, as of the class of 1918,	Boston.
Simmons, Lester Winslow,	Dighton.
Skinner, Everett Hamilton, as of the class of 1919,	West Upton.
Smith, George Alfred,	Whitinsville.
Smith, Raymond Newton,	Plainville.
Smith, Susan Almira,	Great Barrington.
Spaulding, Harold Edwin,	Milford.
Stedman, Ralph Shaw,	Springfield.
Stowe, Raymond Timothy, as of the class of 1918,	Scitico, Conn.
Sullivan, Walter Mitchell,	Lawrence.
Swift, Raymond Walter, as of the class of 1918,	North Amherst.
Taylor, Elliot Hubbard,	Shelburne.
Thayer, Weston Cushing, as of the class of 1918,	Hingham.
Tirrell, Loring Vinson, as of the class of 1919,	South Weymouth.
Urquhart, John Wardrop,	East Walpole.
Williams, Allan Carruth,	Rockland.
Window, James Joseph, as of the class of 1919,	Springfield.
Woodbury, Ray Willard, as of the class of 1918,	Newburyport.

Wooding, Paul Bennett, as of the class of 1918,	Yalesville, Conn.
Woodward, George Blossom,	Albany, N. Y.
Worthley, Harlan Noyes, as of the class of 1918,	Amherst.
Wright, Stuart Eldridge,	Raynham Center.

Bachelor of Science, Honoris Causa.

Baker, Foster Kenneth,	Fairhaven.
Clapp, Roger Francis,	Salem.
Coderre, Ernest Laurier,	Southbridge.
Harwood, Ralph Wallace,	Barre.
Heffron, Paul John,	Sherborn.
Norcross, Gardner Clyde,	Brimfield.
Pond, Allan Leon,[1]	Holliston.
Richardson, Stephen Morse,	Montague.
Sampson, Fred Bucknam,	Fall River.

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[1] Deceased.

Registration, 1920-21.

Graduate Students.

Avery, Roy C., B.S., Connecticut Agricultural College.	New York City.
Baldwin, C. H., A.M., Dallas College. B.D., Hartford Theological Seminary.	Cummington.
Bonnell, Anna Vreeland, A.M., Mt. Holyoke College.	Elizabeth, N. J.
Buchanan, Walter Gray, B.Sc., Massachusetts Agricultural College.	Amherst.
Campbell, Malcolm D., B.Sc., Worcester Polytechnic Institute.	Raynham.
Campbell, Walter, A.M., Princeton University.	Springfield.
Clark, Dorothy Porter, B.A., Wellesley College.	Newton.
Coleman, Elizabeth, A.B., Smith College.	Scranton, Pa.
Dooley, Thomas P., B.Sc., Massachusetts Agricultural College.	Dorchester.
Drain, Daniel Brooks, B.Sc., Ohio State University.	Amherst.
Drexel, Richard Jacob, B.S.A., Georgia State College.	Tifton, Ga.
Elder, Thomas Edwin, B.Sc., Cornell University.	Mount Hermon.
Emery, Herbert M., B.Sc., Massachusetts Agricultural College.	Newburyport.
Faneuf, Ambrose, B.Sc., Massachusetts Agricultural College.	West Warren.
Farrar, Harry Allen, B.Sc., Middlebury College.	Middleton.
Folsom, Josiah C., B.Sc., Massachusetts Agricultural College.	South Hadley.
Frellick, Arthur L., B.Sc., Massachusetts Agricultural College.	Everett.
Frellick, Ralph S., B.S., Franklin College.	Everett.
French, Rowland B., B.S., Dartmouth College.	Haverhill.
Gagnon, Aime, B.A., Laval University.	Laprairie, P. Q., Can.
Garvey, Mary Ellen M., B.Sc., Massachusetts Agricultural College.	Amherst.
Gifford, George Endicott, B.S., Boston University.	Middleton.
Glover, Theodore W., Jr., B.Sc., Massachusetts Agricultural College.	North Easton.
Gould, Charles H., B.Sc., Massachusetts Agricultural College.	Amherst.
Harris, Roy Dudley, B.Sc., Middlebury College.	Middlebury, Vt.

Hood, Egerton Gibson, B.S.A., Ontario Agricultural College.	Macdonald College, P. Q., Can.
Julian, Arthur H., B.A., Northwestern University.	Amherst.
Lieber, Conrad H., B.Sc., Massachusetts Agricultural College.	Jamaica Plain.
Mather, Fred C., B.Sc., Massachusetts Agricultural College.	Amherst.
Merritt, L. A., B.S., Trinity College.	Williamsburg.
Montesanto, John Emile, B.A., International College, Smyrna, Turkey.	Melrose.
Morin, Adrien, B.S.A., École d'Agriculture de Ste. Anne de la Pocatière, Can.	Saint-Celestin, P. Q., Can.
Neill, James A., B.S., Allegheny College.	Clarion, Pa.
Nirodni, B. S., B.A., University of Madras, India.	Byndoor, India.
O'Brien, Daniel W., B.Sc., Massachusetts Agricultural College.	Natick.
Perrins, Arthur W., Jr., A.B., Harvard University.	Enfield.
Porter, Randall R., B.S., Wesleyan University.	Columbia, Conn.
Rand, Helen Margaret, A.M., Radcliffe College.	Fairfield, Idaho.
Sanborn, Joseph Raymond, B.Sc., Massachusetts Agricultural College.	North Amherst.
Sanctuary, Wm. Crocker, B.S., Massachusetts Agricultural College.	Morrisville, N. Y.
Stratford, Reginald Kilmaster, Ontario Agricultural College (Toronto University).	Toronto, Ont., Can.
Taylor, Raymond Stevens, B.Sc., Pennsylvania State College.	Newton, Pa.
Thelin, Guy, B.Sc., South Dakota State College.	Sioux Falls., S. D.
Towle, Dorothy, B.A., Mt. Holyoke College.	Westfield.
Ward, Charles L., B.Sc., Harvard University.	Andover.
Watson, Esther, B.S., Teachers' College, Columbia University.	Boston.
Wells, Reuben F., B.A., Amherst College.	Hatfield.
Wolfe, Benjamin Franklin, B.S.A., Purdue University.	Columbia City, Ind.

Enrolled in 1919–20, after List was published.

Mikami, S., Hokkaido Imperial University.	Tokyo, Japan.
Torrey, Hamilton, B.Sc., University of Pennsylvania.	Springfield.
Tower, Alfred L., B.Sc., Massachusetts Agricultural College.	Sheffield.

CLASS OF 1921 (SENIORS).

Alger, James Warren,[1]	Reading,	Kappa Sigma.
Allen, Harold Kenneth,	Belchertown,	Belchertown.
Allen, Henry Vaughn,[1]	Arlington,	Phi Sigma Kappa.
Anderson, Charles Henry,	Medford,	Theta Chi.
Armstrong, Philip Brownell,	Rutherford, N. J.,	Phi Sigma Kappa.

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[1] Work incomplete.

Bailey, William, Jr.,	Williamstown,	Stockbridge Hall.
Baker, Louis Eliot,	Salem,	13 South College.
Baker, Russell Dexter,	Oxford, Me.,	Lambda Chi Alpha.
Ball, Lorin Earl,	Amherst,	Q. T. V.
Bögholt, Carl Miller,	Newport, R. I.,	Q. T. V.
Boynton, Raymond Woods,	Framingham,	Alpha Sigma Phi.
Brigham, John Dexter,[1]	Sutton,	16 South College.
Brown, Paul Wilfred,	Fiskdale,	Lambda Chi Alpha.
Bunker, Carroll Wooster,	Dorchester,	Q. T. V.
Calhoun, Salteau Frederick,	Brookline,	The Davenport.
Cameron, Viola Mary,[1]	Amherst,	Amherst, R. F. D. 2.
Cascio, Peter Joseph,	Willimantic, Conn.,	Sigma Phi Epsilon.
Coombs, Roger Conklin,	Peabody,	Sigma Phi Epsilon.
Cooper, Lawrence Melville,[1]	Charlemont,	Alpha Gamma Rho.
Davenport, Frank Semore,[1]	Dorchester,	Alpha Sigma Phi.
Davidson, Donald Gordon,	Amherst,	10 Boltwood Avenue.
Davis, Orrin Chester,	Belchertown,	Alpha Gamma Rho.
Dean, Herman Nelson,	Oakham,	Q. T. V.
Douglass, Donald Churchill,[1]	Cambridge,	Phi Sigma Kappa.
Dunbar, Charles Oliver,	Westfield,	84 Pleasant Street.
Edman, George William,[1]	Orange,	The Davenport.
Evers, Joseph Daniel,	Malden,	Sigma Phi Epsilon.
Fletcher, Francis Summers,	East Lynn,	Alpha Gamma Rho.
Fuller, Lorenzo,	Lowell,	Mathematics Building.
Gaskill, Harland Everett,	Hopedale,	Alpha Sigma Phi.
Geer, Herbert Leroy,	Three Rivers,	Q. T. V.
Gillette, Nathan Warner,[1]	Revere,	Q. T. V.
Gilligan, Gerald Mathew,	West Warren,	Kappa Gamma Phi.
Goff, Howard Mason,	Cambridge,	Phi Sigma Kappa.
Gould, Robert Meredith,	Shelburne,	Q. T. V.
Gray, Irving Emery,	Woods Hole,	Alpha Gamma Rho.
Hagar, Joseph Archibald,	Marshfield Hills,	Kappa Sigma.
Haskins, Harold Arthur,	North Amherst,	North Amherst.
Haslam, Emerson Francis,	Westwood,	Theta Chi.
Howard, Frederic,	Mansfield,	Lambda Chi Alpha.
Howe, George Cole,	Amherst,	81 Pleasant Street.
Hunter, Harold Clayton,[1]	South Hadley Falls,	Alpha Sigma Phi.
Hurd, Davis Alden,	Wellesley Hills,	French Hall.
Hurd, Gordon Killam,[1]	Millbury,	Physics Laboratory.
Iorio, Carlo Antonio,	Springfield,	East Experiment Station.
Jones, Robert Lambert,	Attleboro,	Q. T. V.
Kendall, Charles Donald,[1]	Worcester,	Q. T. V.
Kimball, William Lincoln,	Orange,	Phi Sigma Kappa.
King, Starr Margetts,	Pittsfield,	Kappa Sigma.
Kirkland, Lyle Lord,	Chester,	77 Pleasant Street.
Knight, Frank Edward,	Brimfield,	South College.
Labrovitz, Edward Browdy,	Amherst,	11 Amity Street.
Lambert, Richard Bowles,	Gleasondale,	Lambda Chi Alpha.
Leavitt, Ralph Goodwin,[1]	Melrose,	Theta Chi.
Leighton, Arthur Whiting,	Abington,	9 Fearing Street.
Lent, Donald Ashford,	Maynard,	Alpha Gamma Rho.
Lincoln, Newton Ewell,	Dorchester,	Alpha Gamma Rho.
Lockwood, George Russell,	Waban,	Theta Chi.
Long, Albert Douglas,	Amherst,	Sigma Phi Epsilon.
Mackintosh, Charles Gideon,	Peabody,	Phi Sigma Kappa.
Mallon, Charles Hugh,	East Braintree,	Phi Sigma Kappa.
Mansell, Elton Jessup,[1]	Cambridge,	Phi Sigma Kappa.
Martin, Lawrence Paul,	Malden,	Alpha Sigma Phi.
McCarthy, Justin Jeremiah,	Arlington,	Phi Sigma Kappa.
Mellen, Richard Adams,	Cambridge,	Sigma Phi Epsilon.
Newell, Philip Sanger,	West Newton,	Phi Sigma Kappa.
Newton, Edward Buckland,	Holyoke,	Commons Club.

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[1] Work incomplete.

O'Hara, Joseph Ernest,	Worcester,	8 Kellogg Avenue.
Palmer, Walter Isaiah,[1]	Amherst,	13 South Prospect Street.
Peck, Richard Charles,	Shelburne,	West Experiment Station.
Poole, Harold Walter,	Hudson,	10 South College.
Pratt, Laurence Francis,	North Weymouth,	Q. T. V.
Preston, Everett Carroll,	Dorchester,	20 South College.
Quint, Isador Gabriel,	Roxbury,	13 South College.
Reed, Morris,	Worcester,	14 South College.
Rice, Henry Lawrence,	Somerville,	Kappa Sigma.
Robinson, Philip Luther,[1]	New Bedford,	Alpha Gamma Rho.
Rosoff, Samuel Nathaniel,	Springfield,	13 South College.
Russert, Marion Ruth,	Boston,	Adams House.
Sampson, Howard Jenney,[1]	Fall River,	Theta Chi.
Sanford, Richard Herbert,	Westfield,	Sigma Phi Epsilon.
Slate, George Lewis,	Bernardston,	Alpha Gamma Rho.
Sloan, Kenneth Wilson,	Amherst,	29 North Prospect Street.
Smith, Jonathan Harold,	Roslindale,	Theta Chi.
Smith, Richard Watson, Jr.,	Sylacauga, Ala.,	Q. T. V.
Snow, John Dow,	Arlington,	Phi Sigma Kappa.
Starkey, Robert Lyman,	Fitchburg,	Phi Sigma Kappa.
Stevens, Ralph Shattuck,[1]	Arlington,	Theta Chi.
Stiles, Harry Stephen,	Lynn,	Kappa Gamma Phi.
Tietz, Harrison,	Richmond Hill, L. I., N. Y.,	37 Cottage Street.
Tillson, Reginald Drury,	Whitman,	21 Fearing Street.
Van Lennep, Emily Bird,	Great Barrington,	Adams House.
Waite, Richard Austin,	Middlefield,	Alpha Gamma Rho.
Watkins, Tscharner Degraffenreidt,[1]	Midlothian, Va.,	Kappa Sigma.
Webster, Milton Fuller,	Malden,	Kappa Gamma Phi.
West, Guy Clifford,	Amesbury,	Kappa Gamma Phi.
Zercher, Frederick Kaupp,[1]	Huntington, W. Va.,	Clark Hall.

Class of 1922 (Juniors).

Acheson, Roger Melvin,	New Bedford,	Alpha Gamma Rho.
Andrews, John Hollis,	Vineyard Haven,	15 North College.
Bainton, Hubert Judson,[1]	Hyde Park,	12 North College.
Baker, George Louis,	Amherst,	124 West Street.
Barnard, Kenneth Allen,	Shelburne,	Q. T. V.
Beckwith, Robert Henry,	Wellesley Hills,	Entomological Building.
Bent, Leslie Dana,[1]	Medfield,	Lambda Chi Alpha.
Blakely, Roger Wolcott,	Medford,	3 Hallock Street.
Blanchard, Raymond Stanwood,	Wollaston,	3 North College.
Bromley, Stanley Willard,	Southbridge,	Alpha Gamma Rho.
Buck, Charles Alfred,	Mansfield,	Alpha Gamma Rho.
Burnett, Paul Lapham,[1]	Leicester,	11 South College.
Burnham, Edwin Graham,	Springfield,	Lambda Chi Alpha.
Carey, Edmund Thomas,	Springfield,	Kappa Gamma Phi.
Chapin, Ellis Warren, Jr.,[1]	Chicopee Falls,	15 North College.
Chase, Eleanor Frances,	Amesbury,	Adams House.
Clark, Clarence Frederick,	Sunderland,	Q. T. V.
Collins, Donald Keith,[1]	Rockland,	Theta Chi.
Collins, Herbert Laurence,	Arlington,	Sigma Phi Epsilon.
Conant, Luman Binney,[1]	Waltham,	5 South College.
Cook, Frederick Belcher,	Niantic, Conn.,	Commons Club.
Cotton, George Asa,[1]	Woburn,	Sigma Phi Epsilon.
Crawford, Alexander George,	Waverley,	15 South College.
Davis, Harold Sanborn,[1]	Belchertown,	Belchertown.
Degener, Otto,[1]	New York, N. Y.,	The Davenport.
Dwyer, James Edward,[1]	Sunderland,	Alpha Sigma Phi.
Erysian, Harry Adrian,[1]	Chelsea,	North College.
Field, Richard Edmund,	Shelburne Falls,	Q. T. V.
Freeman, Stanley Leonard,	Needham,	Mathematics Building.

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[1] Work incomplete.

Gilbert, Frank Albert, Jr.,	Brandon, Vt.,	Lambda Chi Alpha.
Gowdy, Carlyle Hale,	Westfield,	103 Pleasant Street.
Haskins, Philip Hall,[1]	North Amherst,	North Amherst.
Higgin, Albert Snyder,	Passaic, N. J.,	Alpha Sigma Phi.
Hodgson, Robert Moore,	Newport, R. I.,	30 North Prospect Street.
Holman, Reginald Newton,	Somerville,	Q. T. V.
Hooper, Francis Edwards,	Revere,	Sigma Phi Epsilon.
Hurder, Ruth Wasson,[1]	Milton,	Adams House.
Hussey, Francis William,[1]	Whitinsville,	3 North College.
Jackson, Belding Francis,	Belchertown,	Belchertown.
Kemp, George Austin,	North Andover,	Lambda Chi Alpha.
Knapp, Irving Robinson,[1]	Seekonk,	3 North College.
Kokoski, Frank Joseph,	Amherst,	Amherst, R. F. D. 3.
Krasker, Abraham,[1]	Revere,	14 South College.
Kroeck, Julius, Jr.,	Huntington, L. I., N. Y.,	Phi Sigma Kappa.
Lacroix, Donald Sewall,[1]	Rowley,	Alpha Gamma Rho.
Law, Hervey Fuller,	Longmeadow,	Care of Mr. C. W Everson.
Lawrence, Robert Parker,	East Greenwich, R. I,	11 North College.
Leland, James Freeman, Jr.,[1]	Sherborn,	Alpha Sigma Phi.
Leonard, Earle Stanley,[1]	Hyde Park,	Lambda Chi Alpha.
Lewandowski, John Neptumcen,[1]	Easthampton,	Alpha Sigma Phi.
Lindquist, Harry Gotfred,	Holden,	7 North College.
Lockhart, John Harold,[1]	Tarrytown, N. Y.,	Theta Chi.
Lovering, Everett Waldron,	Northampton,	283 Prospect Street, Northampton.
Lovering, Rolland Frederick,[1]	Northampton,	283 Prospect Street, Northampton.
Lowery, John Gordon,	Malden,	Kappa Sigma.
Lyons, Edgar Albion,	Methuen,	7 North College.
Lyons, John Joseph, Jr.,[1]	Arlington,	Sigma Phi Epsilon.
MacArdle, Herbert Aloysius,	Worcester,	Kappa Gamma Phi.
Main, Stuart DeGroff,	Maplewood, N. J.,	101 Butterfield Terrace.
Martin, Edward William,	Amherst,	5 Phillips Street.
McGuinn, Albert Francis,	Worcester,	83 Pleasant Street.
Moody, Kenneth Watts,	Brookline,	Lambda Chi Alpha.
Moseley, Henry Samson,[1]	Glastonbury, Conn.,	Alpha Sigma Phi.
Murdock, Matthew John,	Medford,	Q. T. V.
Murray, Harry Athol, Jr.,	Arlington,	West Experiment Station.
Murray, Myron George,	Davenport, Iowa,	Lambda Chi Alpha.
Nigro, Henry,	Revere,	15 North College.
Packer, George Blanchard,[1]	Waterbury, Conn.,	Sigma Phi Epsilon.
Peck, William Henry,	Stow,	11 North College.
Perry, Helen Margaret,[1]	Waltham,	Adams House.
Pickup, Ezra Aldon,[1]	Holyoke,	6 North College.
Pollard, Jane Isabel,[1]	North Adams,	Adams House.
Randall, Kenneth Charles,	Springfield,	East Experiment Station.
Reed, Paul Malcolm,[1]	Baldwinville,	Phi Sigma Kappa.
Richardson, Marjory,[1]	Millis,	Adams House.
Rollins, Walter Jessie,[1]	Westminster, Vt.,	Sigma Phi Epsilon.
Roser, Conrad Herman,[1]	Glastonbury, Conn.,	Phi Sigma Kappa.
Russell, Ralph,	Worcester,	2 North College.
Sherman, Kenneth David,[1]	Orange,	2 North College.
Smith, Albert William,	Easthampton,	15 South College.
Smith, Donald Hiram,[1]	Pittsfield,	Sigma Phi Epsilon.
Smith, Maxfield Merriam,[1]	Pittsfield,	Phi Sigma Kappa.
Smith, Rowland Piper,[1]	North Amherst,	46 Pleasant Street.
Spring, Hobart Wadsworth,[1]	Braintree,	Q. T V.
Sullivan, Joseph Timothy,	Lawrence,	Alpha Gamma Rho.
Swift, Arthur Lawrence,[1]	North Amherst,	Summer Street, North Amherst.
Talmage, Harry John,[1]	Springfield,	Commons Club.
Tanner, Willis,[1]	Worcester,	Commons Club.
Thompson, George Henry, Jr.,	Lenox,	Sigma Phi Epsilon.

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[1] Work incomplete.

Tucker, Francis Sample,[1]	Arlington,	Alpha Sigma Phi.
Vinton, Charles Raymond,[1]	Roxbury,	Theta Chi.
Walker, Philip Duane,	Hardwick,	Alpha Sigma Phi.
Walsh, John Leonard,[1]	Amherst,	35 East Pleasant Street.
Warren, Edwin Herbert,	Chelmsford,	Lambda Chi Alpha.
Waugh, Frederick Vail,	Amherst,	Kappa Sigma.
Weber, Harold Richard,[1]	Brooklyn, N. Y.,	4 Chestnut Street.
Wentsch, Harold Earle,	Southbury, Conn.,	Kappa Gamma Phi.
Whitaker, Carl Fales,[1]	Hadley,	Kappa Sigma.
White, George Edwin,	Worcester,	Kappa Gamma Phi.

Class of 1923 (Sophomores).

Abele, Trescott Tupper,	Quincy,	16 North College.
Alexander, Donald Briggs,[1]	Boston,	29 North Prospect Street.
Alger, Mason Williams,	West Bridgewater,	Alpha Gamma Rho.
Ames, Nathaniel Jackson,[1]	Peabody,	Kappa Sigma.
Arrington, Luther Bailey,	Florence,	Alpha Gamma Rho.
Baker, Howard,	Marshfield,	Sigma Phi Epsilon.
Bartlett, Warren Leslie,[1]	Roslindale,	Phi Sigma Kappa.
Bateman, Eleanor Willard,	Arlington Heights,	Adams House.
Bates, Howard,	Beechwood,	Kappa Gamma Phi.
Bates, Robert Brooks,	West Springfield,	Alpha Gamma Rho.
Beal, James Allen,	Abington,	Kappa Sigma.
Bennett, James Stanley,	South Meriden, Conn.,	Alpha Gamma Rho.
Boles, Inza Almena,	Dorchester,	Adams House.
Borgeson, Melvin Benjamin,[1]	Worcester,	Kappa Gamma Phi.
Brewer, Gardner Hunter,	Upton,	Commons Club.
Broderick, Lawrence Francis,	Hyde Park,	Commons Club.
Buckley, Francis Edward,[1]	Natick,	Kappa Sigma.
Buell, Robert Allyn,[1]	Orange,	53 Lincoln Avenue.
Burbeck, Joseph Howard,[1, 2]	Peabody,	Sigma Phi Epsilon.
Burke, Edmund William,[1]	Watertown,	Commons Club.
Cohen, Solomon,[1]	Dorchester,	8 North College.
Corash, Paul,	Worcester,	14 South College.
Davis, Frank Langdon,	Lexington,	Phi Sigma Kappa.
Dickinson, Lewis Everett, Jr.,	Holyoke,	Cottage Street.
Dowden, Philip Berry,	Sandwich,	Sigma Phi Epsilon.
Eldredge, Reuel West,	Winchester,	Kappa Sigma.
Faneuf, John Benedict,	West Warren,	Commons Club.
Fitzpatrick, Leo Joseph,[1]	Brockton,	Commons Club.
Folsom, Owen Eugene,	Roslindale,	Phi Sigma Kappa.
Friend, Roger Boynton,	Dorchester,	Alpha Gamma Rho.
Fuller, Robert Donald,	Woburn,	Q. T. V.
Gamzue, Benjamin,	Holyoke,	8 North College.
Gay, Alfred Fullick,	Groton,	Theta Chi.
Gerry, Bertram Irving,[1, 2]	Peabody,	Alpha Gamma Rho.
Gildemeister, Mary Katherine,[1]	Belchertown,	Adams House.
Gold, Philip,[1]	Roxbury,	56 Pleasant Street.
Goldstein, Joseph,[1, 2]	Lynn,	14 South College.
Gordon, Howard Reynolds,[1]	Ipswich,	Lambda Chi Alpha.
Grayson, Raymond Henry,[1]	Milford,	Alpha Sigma Phi.
Hale, John Stancliff,	South Glastonbury, Conn.,	Phi Sigma Kappa.
Hallett, Melvin Bernard,[1]	Rockland,	East Experiment Station.
Hardy, Sherman Keeler,[1]	Littleton,	The Davenport.
Harrington, Robert John,[1]	Holyoke,	Alpha Sigma Phi.
Heath, Allan Jay,[1]	Newfane, Vt.,	13 North College.
Hilyard, Norman Douglas,[1]	Beverly,	Q. T. V.
Hodsdon, Marshall Sinclair,	Melrose Highlands,	12 South College.
Holley, George Gilbert,[2]	Fiskdale,	Lambda Chi Alpha.
Hollis, Frederick Allen,	Charlton,	1 North College.
Hosmer, Frank Howard,[1]	Greenfield,	Theta Chi.

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[1] Work incomplete. [2] Admitted on service record. Entrance record not complete.

Hunter, Henry Leander, Jr.,[1]	Mount Kisco, N. Y.,	Theta Chi.
Irish, Gilbert Henry,	Turner, Me.,	Lambda Chi Alpha.
Johnson, Cleon Bancroft,[1]	Ipswich,	6 Nutting Avenue.
Johnson, Eyrle Gray,[1]	Mattapan,	Lambda Chi Alpha.
Jones, Alan,[1]	Boston,	1 North College.
Keith, Clifford Woodworth,[1]	Providence, R. I.,	Mount Pleasant.
Labrovitz, Rose Florence,	Amherst,	11 Amity Street.
Latour, Oliver Page,[1]	Worcester,	Kappa Gamma Phi.
Lewis, Molly LeBaron,	Jamaica Plain,	Adams House.
Lindskog, Gustaf Elmer Richard,	Roxbury,	Clark Hall.
Luddington, Frank Dennison,[1]	Hamden, Conn.,	23 East Pleasant Street.
MacCready, Donald Eugene,[1]	Elizabeth, N. J.,	12 South College.
Marshall, Alexander Borea,[1]	Manhasset, L. I., N. Y.,	6 Nutting Avenue.
Marshman, Wilbur Horace,[1]	Springfield,	Kappa Sigma.
Martin, Frances Barbara,	Amherst,	5 Phillips Street.
Martin, Robert Fitz-Randolph,	Amherst,	Amherst House.
Mather, Edna,	Amherst,	5 Allen Street.
Mohor, Robert deSales,[1]	Newton Center,	Phi Sigma Kappa.
Mudgett, Vernon Downer,[1]	Brookline,	16 South College.
Nowell, Richard Carll,	West Springfield,	Alpha Gamma Rho.
Norcross, Harry Cecil,[1]	Brimfield,	20 South College.
Nowers, Donald Gilford,[1], [2]	Danvers,	Care of Mr. F. C. Pray, North Amherst.
Paddock, Wallace Earl,	Worcester,	Lambda Chi Alpha.
Perry, Chauncey Valentine,[1]	Waltham,	Poultry Administration Building.
Picard, Charles Francis,[1]	Plymouth,	Commons Club.
Putnam, Ernest Taylor,[1], [2]	Greenfield,	North Amherst.
Ribero, Edwin Francis,[1]	Franklin,	Alpha Sigma Phi.
Richards, Homer Flint,[1]	Reading,	7 Phillips Street.
Richardson, Mark Morton,[1]	West Brookfield,	11 South College.
Roberts, Arthur William,	Hyde Park,	Theta Chi.
Russell, Charles Francis,[1]	Winchendon,	1 Allen Street.
Sandow, Alexander,[3]	Pittsfield,	23 East Pleasant Street.
Sargent, Richmond Holmes,	Buxton, Me.,	103 Pleasant Street.
Sears, Fred Grant, Jr.,	Dalton,	120 Pleasant Street.
Sharpe, Charles Gertner,[1]	Blandford,	15 Spring Street.
Shea, Thomas Francis,[1]	Holyoke,	Kappa Gamma Phi.
Slade, Irving Woodman,	Chelsea,	Kappa Sigma.
Smith, Jeffrey Poole,	West Roxbury,	9 North College.
Snow, Thomas Lathrop,	Greenfield,	Alpha Gamma Rho.
Tanner, Edwin,[1]	Worcester,	Commons Club.
Tarplin, Allan Sebastian,[1]	Brookline,	Entomology Building.
Tarr, James Gordon,[1]	Everett,	29 North Prospect Street.
Task, Mortimer,[1]	West Stoughton,	12 North College.
Tileston, Roger Gordon,[1]	Sharon,	3 Nutting Avenue.
Tisdale, Edward Norman,[1]	Medfield,	Lambda Chi Alpha.
Towne, Carroll Alden,	Auburndale,	Q. T. V.
Towne, Warren Hannaford,	Cambridge,	13 North College.
Tumey, Malcomb Edward,[1]	Greenfield,	Q. T. V.
Turner, Dorothy Van Hoven,	Amherst,	Adams House.
Wendell, Richard Goodwin,	Belmont,	120 Pleasant Street.
Whitaker, Holden,	Newton Highlands,	Q. T. V.
Whittier, John McKey,[1]	Everett,	Kappa Sigma.
Williams, Forrest Earl,	Sunderland,	Q. T. V.
Wirth, Conrad Louis,[1]	Minneapolis, Minn.,	Kappa Sigma.
Woodworth, Leverett Stearns,	Newton,	Care of R. C. Adams, North Amherst.

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[1] Work incomplete.

[2] Admitted on service record. Entrance record not complete.

[3] Admitted on scholarship probation. Entrance record not complete.

CLASS OF 1924 (FRESHMEN).

Argy, Warren George,[1]	Turners Falls,	5 Farview Way.
Armstrong, Bradford,	Kensington, Md.,	3 Allen Street.
Arrangelovich, Danitza,[2]	Belgrad, Serbia,	Adams House.
Atkins, Harold Kent,[1]	Weehawken, N. J.,	73 Pleasant Street.
Ball, Kenneth Moore,	Bloomfield, N. J.,	Care of R. C. Adams, North Amherst.
Barker, John Stuart,	West Bridgewater,	17 Fearing Street.
Barrows, Robert Arthur,[1]	Quincy,	7 Nutting Avenue.
Barteaux, Frank Everett,	Framingham,	53 Lincoln Avenue.
Bartlett, Frederick Sheldon,	Westfield,	31 East Pleasant Street.
Bartlett, Perry Goodell,	Holyoke,	6 North College.
Belden, Clifford Luce,	Bradstreet,	15 Fearing Street.
Bike, Edward Louis,	Westfield,	31 East Pleasant Street.
Bilske, Francis Paul,	Hadley,	Hadley.
Blanchard, Norman Harris,[1]	Pittsfield,	7 Nutting Avenue.
Bliss, Elisha French, Jr.,	Springfield,	17 Fearing Street.
Bowers, Frank Henry, Jr.,[1]	Mansfield,	17 Fearing Street.
Bowes, Charles Atwell,	Worcester,	McClure Street.
Bowes, Curtis Glover,	Swampscott,	83 Pleasant Street.
Brickett, Paul Eastman,[1]	West Lynn,	41 East Pleasant Street.
Brunner, Fred, Jr.,	New York, N. Y.,	6 Nutting Avenue.
Cahalane, Victor Harrison,	Charlestown, N. H.,	116 Pleasant Street.
Carpenter, Earle Stanton,	Rehoboth,	116 Pleasant Street.
Chase, Theodore Martin,	Milton,	Mount Pleasant.
Clark, Charles O'Reilly,	Beachmont,	101 Pleasant Street.
Collins, Oscar Ernest,	Fitchburg,	7 Phillips Street.
Cromack, Earl Augustus,[1]	Shelburne,	15 Fearing Street.
Cummings, Leslie Samuel,	Webster,	120 Pleasant Street.
Darling, Robert Martin,	Cambridge,	66 Pleasant Street.
Davis, Howard Halsey,	Brockton,	17 Fearing Street.
Davis, Stanley Whitcomb,	Rockland,	7 Phillips Street.
Deuel, Charles Frederick, 2d,[1]	Amherst,	30 Lincoln Avenue.
Dresser, Allen Lucius,	Leominster,	66 Pleasant Street.
DuBois, Martin Lee,	New Paltz, N. Y.,	44 Triangle Street.
Eaton, William Henry,	Wilbraham,	30 North Prospect Street.
Elliott, James Alexander,[2]	Summit, N. J.,	Care of Mr. George Cooley, Sunderland.
Emery, George Edward,	Marlborough,	31 East Pleasant Street.
Epps, Martha Belle Scott,	Wilbraham,	Adams House.
Fenton, John Michael,[2]	Amherst,	108 Pleasant Street.
Fernald, Leland Hoyt,[1]	Concord,	10 North College.
Ferranti, Edmund Tony,	West Bridgewater,	17 Fearing Street.
Flint, Ruth Guild,	Boston,	Adams House.
Frost, Sherman Clark,[1]	West Somerville,	3 Nutting Avenue.
Frost, Willard Chamberlain,	Milford,	21 Fearing Street.
Garretson, Alfred Corwin,	Bound Brook, N. J.,	Care of Mr. M. W. Hoyt.
Geiger, Aimee Suzanne,[1]	Pepperell,	Adams House.
Gifford, Richard Smith,	South Westport,	7 Nutting Avenue.
Goldsmith, Eliot Gray,	Brookline,	32 North Prospect Street.
Grieve, Alexander Watson,	Dorchester,	4 North College.
Gryzwacz, Patrick Louis,	Ware,	101 Pleasant Street.
Hairston, Joseph Jester,[1]	Homestead, Pa.,	10 Beston Street.
Haskell, Malcolm Rawson,	Amherst,	27 Main Street.
Hayden, Luther Leonard, Jr.,	Brookville,	13 Phillips Street.
Hayes, William Bointon,	South Deerfield,	73 Pleasant Street.
Hill, Carroll Victor,[1]	Worcester,	9 Phillips Street.
Holteen, John Gunnar,	Quincy,	15 Hallock Street.
Holway, Clarence Waren,[1]	Holden,	4 Chestnut Street.

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[1] Work incomplete.

[2] Admitted on scholarship probation. Entrance record not complete.

Hopkins, David,	Medford,	42 McClellan Street.
Hubbard, Doris,[1]	Newton,	Adams House.
Humphrey, Laurence Edmund,[1]	Wareham,	27 Fearing Street.
Hutchins, Osburne Amos,[1]	Shelburne,	10 Nutting Avenue.
Isaac, Carl Frederick,	Brighton,	35 East Pleasant Street.
Kane, Edward Anthony,[1]	Westfield,	17 Phillips Street.
Kennedy, Lowell Francis,	Cambridge,	18 Nutting Avenue.
Kilbourn, James Sheldon,[1]	Cambridge,	Care of Mrs. Russell, Cottage Street.
King, Rosewell Howard,[1]	Millville,	23 East Pleasant Street.
Lal, Prem Chand,[2]	India,	North College.
Lamb, Eric Franklin,[1]	Waban,	81 Pleasant Street.
Lano, Wilfred Craig,	Fitchburg,	7 Phillips Street.
Leathe, William Wallace,[1]	Larchmont, N. Y.,	35 East Pleasant Street.
Leland, Allen Sanford,	East Bridgewater,	6 Nutting Avenue.
Loring, Kenneth Stockwell,	Melrose Highlands,	1 Allen Street.
Lyons, Mildred Harris,[1]	Holyoke,	Adams House.
MacAfee, Norman Hoar,	Cambridge,	41 East Pleasant Street.
Macauley, Donald Francis,[1]	Beverly,	42 McClellan Street.
Mader, Russell Curtis,	Waltham,	2 McClellan Street.
Manchester, Philip,	Fall River,	18 Nutting Avenue.
McElroy, James Ernest,[1]	Orange,	6 Nutting Avenue.
Merrick, Charles Llewellyn,	Wilbraham,	30 North Prospect Street.
Merrick, Stuart Halliwell,	Wilbraham,	30 North Prospect Street.
Miller, Warwick Baise,[1]	Providence, R. I.,	53 Lincoln Avenue.
Morris, Walter Markley,[1]	Amherst,	8 Nutting Avenue.
Morse, Alfred Bullard,[1]	Oakham,	4 Chestnut Street.
Morse, Howard Babbidge,[1]	Townsend,	30 North Prospect Street.
Myrick, Sterling,	Longmeadow,	84 Pleasant Street.
Nelson, Carl Olaf,	Gloucester,	13 Phillips Street.
Nicoll, Arthur Chester,[1]	Quincy,	7 Nutting Avenue.
Noyes, Russell,	Newtonville,	25 North Prospect Street.
Nutting, Raymond Edwin,	Fitchburg,	7 Phillips Street.
Oklobdzia, Boris,[2]	Bosnia, Serbia,	51 Amity Street.
Palmer, Harold Conwell,[1]	Amherst,	13 South Prospect Street.
Pearson, John Cleary,[1]	Cambridge,	116 Pleasant Street.
Percival, Gordon Pittinger,	Medfield,	18 Nutting Avenue.
Poey, Frederick,[2]	Havana, Cuba,	42 McClellan Street.
Porges, Nandor,	Hyde Park,	56 Pleasant Street.
Pratt, Wallace Francis,	Rockland,	17 Fearing Street.
Read, John Gammons,	Springfield,	73 Pleasant Street.
Reynolds, Joseph Sagar,[1]	Attleboro,	14 North College.
Rhodes, Winthrop Gordon,	Waban,	25 North Prospect Street.
Ricker, Chester Sewall,[1]	Worcester,	120 Pleasant Street.
Roeder, Frank Richason,	Turners Falls,	6 Nutting Avenue.
Root, Frank Edson,	Bernardston,	83 Pleasant Street.
Rowell, Elwyn Joseph,	Amherst,	44 Triangle Street.
Salman, Kenneth Allen,	Needham,	11 North College.
Schaffer, Carlton Hill,[1]	Ashfield,	17 Phillips Street.
Sellers, Wendell Folsom,[1]	Melrose,	9 Phillips Street.
Shepard, Harold Henry,[2]	South Royalston,	8 Kellogg Avenue.
Sherman, Willis Whitney,[1]	Dorchester,	Care of Mr. H. N. Worthley, Mount Pleasant.
Sime, Arnold Jay,[1]	Adams,	29 North Prospect Street.
Sims, Kenneth Wallace,	South Boston,	3 Allen Street.
Slack, Marion Florence,	Brookline,	Adams House.
Smith, Richard Burr,	Greenfield,	Phi Sigma Kappa.
Smith, Vera Irene,	Amherst,	Adams House.
Staebner, Alfred Porter,[1]	Willimantic, Conn.,	46 Triangle Street.
Steele, Charles Wasser,	Marblehead,	10 North College.
Steere, Robert Ernest,	Chepachet, R. I.,	116 Pleasant Street.

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[1] Work incomplete.

[2] Admitted on scholarship probation. Entrance record not complete.

Sterling, Ann,[1]	Lancaster,	Adams House.
Stevenson, Harold Dudley,	Camden, Me.,	8 Nutting Avenue.
Stone, George Leroy,	Montello,	120 Pleasant Street.
Tewhill, Charles James,	Florence,	6 Nutting Avenue.
Thompson, Alice Elizabeth,	Amherst,	Mount Pleasant.
Thornton, Clarence Percy,[1]	Pelham,	Pelham.
Tobey, Charles Sylvester,	Belmont,	7 Nutting Avenue.
Turner, Dana Burwell,[1]	Chester,	53 Lincoln Avenue.
Varnum, Thomas, Jr.,[1]	Lowell,	66 Pleasant Street.
Waugh, Albert Edmund,	Amherst,	M. A. C.
Weatherwax, Howard Erle,[1]	Greenfield,	116 Pleasant Street.
White, Samuel Henry,	Orange,	10 North College.
Whitman, Chester Edgerly,[1]	Suffield, Conn.,	4 Chestnut Street.
Whitney, Will Alvah,	Taunton,	4 North College.
Wilhelm, George Henry,	Holyoke,	4 Chestnut Street.
Williams, James Lowell,	Sunderland,	6 Nutting Avenue.
Witt, Earl Maynard,	Belchertown,	Belchertown.
Wood, Ruth Millicent,[1]	North Andover,	Adams House.
Wood, William Wilson,	Barre Plains,	23 East Pleasant Street.
Woodworth, Robert Hugo,[1]	Newton,	Care of R. C. Adams, North Amherst.

Unclassified Students.

Collins, John Lucie,	Wakefield,	The Perry.
Gahan, Laurence Keith,	Worcester,	4 Chestnut Street.
Goodale, Geoffrey Dearborn,	Boston,	8 Nutting Avenue.
Gustin, Francis Borden,	North Amherst,	North Amherst.
Hemenway, Rachel Viola,	Williamsburg,	Adams House.
Richardson, Lester Thornley,	Waltham,	44 Pleasant Street.
Stevens, Richard Clinton,	Winchester,	9 Fearing Street.
Stockbridge, John Sylvester,	Atlanta, Ga.,	Kappa Sigma.
Tattan, Francis David,	Cambridge,	Stockbridge Hall.
Wendler, Henry George,	Clinton,	Stockbridge Hall.

Registered after the Catalogue for 1919 was published.

Bagdasarian, Albert Charles,	Cambridge.
Hagen, Sophus,	Maplewood.
Kimball, William Howard,	Rehoboth.
Martinovich, Petar,	Serbia.
Rawding, Stanley Robert,	– –
Searls, Edward Marlborough,	Schaghticoke, N. Y.

Special Students.

Anderson, Verner Sixten,	South Manchester, Conn.,	35 North Prospect Street.
Delaney, Rose Margaret,	Holyoke,	79 Pleasant Street.
Downs, Myron Herbert,	South Jamesport, L. I., N. Y.	83 Pleasant Street.
Egner, Henry Andrew,	Walpole,	17 Pleasant Street.
Kimball, Harold Lincoln,	Waltham,	120 Pleasant Street.
Love, Donald Burt,	Lexington,	120 Pleasant Street.
Merwin, John Demarest,	Southold, L. I., N. Y.,	83 Pleasant Street.
Morrison, Daniel Kenneth,	Newport, R. I.,	120 Pleasant Street.
Regan, Leon Ashley,	Walpole,	18 Nutting Avenue.
Spencer, Miriam Isabelle,	Springfield,	Draper Hall.
Thormond, Felix Crafton,	Houston, Tex.,	101 Pleasant Street.
Wells, Marcus Belden,	North Adams,	120 Pleasant Street.
Wiklund, Carl John,	Norfolk,	17 Pleasant Street.

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[1] Work incomplete.

GEOGRAPHICAL SUMMARY.

Massachusetts,	428
Connecticut,	13
New York,	14
New Jersey,	9
Rhode Island,	7
Maine,	4
Pennsylvania,	4
Vermont,	4
Georgia,	2
Alabama,	1
Idaho,	1
Indiana,	1
Iowa,	1
Maryland,	1
Minnesota,	1
New Hampshire,	1
South Dakota,	1
Texas,	1
Virginia,	1
West Virginia,	1
Canada,	4
Cuba,	1
India,	2
Japan,	1
Serbia,	2
Total,	506

SUMMARY BY CLASSES.

CLASS.	Men.	Women.	Total.
Graduate school,	41	7	48
Senior class, 1921,	94	3	97
Junior class, 1922,	94	5	99
Sophomore class, 1923,	96	8	104
Freshman class, 1924,	124	11	135
Unclassified students,	9	1	10
Special students,	11	2	13
Totals,	469	37	506

SHORT COURSE ENROLLMENT.

TWO-YEAR COURSE IN AGRICULTURE — GRADUATES, 1920.

Bartlett, John Hussey, Jr.,	Nantucket.
Burrington, Reginald Clifton,	North Amherst.
Clapp, Horace Damon,	Easthampton.
Clark, Elbridge Theodore,	Millis.
Davis, Frederick Oscar,	Windsor, Vt.
Frary, Frank Taylor,	Southampton.
Hall, Robert Hancock,	Waverley.
Hawes, Leon Roy,	Sudbury.
Kirchner, Robert Walter,	Pittsfield.
Parsons, Phillips Henry,	Southampton.
Reid, Howard Stanton,	Franklin.
Segelman, Max,	Chelsea.
VanDerpoel, Ernest Collins,	Chicopee Falls.
Wickwire, Harry Wyndom,	Worcester.

RURAL ENGINEERING COURSE — GRADUATES, 1920.

Burt, John Holton,	Hyde Park.
French, Percy Jackson,	Rockland.
Jarvis, Albert Arthur,	East Boston.
Mirault, Joseph Dustin,	Holyoke.
Nelson, Guy Leslie,	Milford, N. H.
Whitbeck, Henry,	Alandar.

VOCATIONAL POULTRY COURSE — GRADUATES, 1920.

Abercrombie, Edward Marion,	Greenfield.
Goodnow, Lewis Weston,	Greenfield.
Hatch, Henry Donald,	Auburn, Me.

TWO-YEAR COURSE, 1920–21.

Second Year.

Allen, Cnester Carolton,	North Amherst,	North Amherst, Box 103.
Almy, Roger Warren,	New Bedford,	29 Lincoln Avenue.
Amsden, Maude Ella,	Petersham,	Adams House.
Baird, Francis William,	Somerville,	44 Pleasant Street.
Barney, Ernest Wellman,	Corinna, Me.,	32 Amity Street.
Baxter, Samuel Ballantine,	Tenafly, N. J.,	75 Pleasant Street.
Bemis, Raymond Battles,	Spencer,	North Amherst.
Bennett, William Whytal,	Arlington,	101 Pleasant Street.
Boland, Albert Moore,	Worcester,	108 Pleasant Street.
Breen, Arthur Joseph,	Granby,	27 Fearing Street.
Bronsdon, William Abbott,	Baldwinsville,	75 Pleasant Street.
Brooker, John Patrick,	Roxbury,	35 North Prospect Street.
Bruce, Mary Elizabeth,	Boston,	Adams House.
Bryant, Frank Kenneth,	Lowell,	8 Kellogg Avenue.
Burke, Leslie Joseph,	Medford,	75 Pleasant Street.
Burnett, Marston,	Lexington,	12 Nutting Avenue.
Burnham, Theodore Shelly,	Essex,	70 Lincoln Avenue.

Cady, Howard Meader,	South Shaftsbury, Vt.,	13 South Prospect Street.
Camp, Emily Blackstone,	Norwich, Conn.,	The Davenport.
Carpenter, Ruth,	Hudson,	Adams House.
Carroll, Margaret Adelaide,	Boston,	Adams House.
Christensen, Frank William,	North Easton,	13 Phillips Street.
Clark, Chester Frederic,	Fitchburg,	North Amherst.
Coles, Howard Finlay,	Tarrytown, N. Y.,	86 Pleasant Street.
Colton, Hartman Dudley,	Springfield,	116 Pleasant Street.
Converse, John Kendrick,	Andover,	108 Pleasant Street.
Corey, Raymond Stanley,	Amherst,	41 East Pleasant Street.
Crocker, Fred Carlton,	Amherst,	30 Cottage Street.
Crosby, Leon Royal,	Tyngsborough,	34 Pleasant Street.
Crowell, Homer Merrill,	Nutley, N. J.,	Gray Street.
Daisy, Walter Edward,	Roslindale,	13 Amity Street.
Dill, Clarence Elmer,	Raynham Center,	31 Pleasant Street.
Doane, Robert Allen,	North Brookfield,	70 Lincoln Avenue.
Dole, Stevens Field,	Shelburne,	7 East Pleasant Street.
DuFresne, Francis Armand,	Lenox,	Hatch Experiment Station.
Dunbar, Charles Basil,	Taunton,	Ye Aggie Inn.
Dunleavy, Henry Jay,	Boston,	2 Tyler Place.
Estey, Roger Bradshaw,	Somerville,	75 Pleasant Street.
Gallant, Daniel Joseph,	Gloucester,	15 Phillips Street.
Gaudette, Claude Isreal,	Boston,	28 Pleasant Street.
Gifford, Franklin Maynard,	Middleborough,	North Amherst.
Girard, Albert John,	East Brimfield,	15 Hallock Street.
Graumann, Lewis Matthew,	Roxbury,	108 Pleasant Street.
Griffin, Artemas Gage,	Westford,	15 Hallock Street.
Hall, Helen,	Milton,	50 Pleasant Street.
Hamilton, Grant Ethan,	Clarksburg,	20 Lessey Street.
Hancock, Russell Hagen,	Vineyard Haven,	5 Nutting Avenue.
Hartling, Wilfred Lewis,	Boston,	16 Amity Street.
Hartwell, Robert Mantor,	Buckland,	116 Pleasant Street.
Haskell, Wilder Alexander,	South Hadley Falls,	15 Hallock Street.
Hayden, Arthur Leo,	Natick,	35 North Prospect Street.
Heinlein, Edward Bancroft,	Dover,	17 Pleasant Street.
Hoyt, Perley Luther,	Perkinsville, Vt.,	20 Lessey Street.
Huckins, Norman Charles,	Dorchester,	34 Pleasant Street.
Huntley, Robert Ernest,	West Somerville,	73 Pleasant Street.
Igo, Bernard James,	West Somerville,	Eastman Lane, Box 476.
Jacques, John William,	Malden,	43 East Pleasant Street.
Jauncey, Oakleigh Wells,	Williamstown,	3 McClellan Street.
Judge, Clarence Peter,	Raynham,	31 Pleasant Street.
Kallio, Tovio Matthew,	Middlefield,	3 North Prospect Street.
Kimball, Howard Augustus,	Littleton,	9 Fearing Street.
Knight, Henry Elbridge,	Amherst,	71 Main Street.
Laurence, Harold Tildon,	Auburndale,	22 North Prospect Street.
Lawton, Edgar Lewis,	Brattleboro, Vt.,	70 Lincoln Avenue.
Libby, Ben Frank,	Springfield,	East Experiment Station.
Libby, Carl Estes,	Springfield,	East Experiment Station.
Lincoln, Leon Patterson,	Barre,	66 Pleasant Street.
Lord, George Walker,	Framingham,	51 Amity Street.
Lounsbury, Francis Edward,	Cambridge,	13 Phillips Street.
MacLeod, Norman Frederick,	Lynn,	108 Pleasant Street.
Macomber, Donald Arthur,	Springfield,	13 Amity Street.
Magoon, Austin William,	Greensborobend, Vt.,	103 Butterfield Terrace.
McFarlan, John Wesley,	Cincinnati, Ohio,	75 Pleasant Street.
Miller, Fred Reuben,	Bernardston,	North Amherst, Box 82.
Morse, Harold Sterling,	Arlington,	23 East Pleasant Street.
Morse, Herbert Edgar,	Foxborough,	18 Nutting Avenue.
Mullen, Frank Myles,	Fayville,	36 North Prospect Street.
Mumford, William Henry,	Springfield,	48 Pleasant Street.
Narkin, Isadore,	Brockton,	56 Pleasant Street.
Newell, Joseph Delaplane,	Brooklyn, N. Y.,	Pleasant Street, care of Mrs. H. D. Fearing.

Norrington, Henry,	Amherst,	25 Gray Street.
Nowers, Rodman Clark,	Danvers,	17 Kellogg Avenue.
Oakes, John Joseph,	Wellesley,	35 North Prospect Street.
O'Brien, Katherine Frances,	Lawrence,	Adams House.
Olson, Niles Theodore,	Dorchester,	2 Tyler Place.
O'Neal, Fred,	Yakima, Wash.,	44 Pleasant Street.
Ownes, Zorayda Kathleen,	Haverhill,	Adams House.
Pagliaro, Frank Mary,	Springfield,	75 Pleasant Street.
Pellis, Abraham,	Chelsea,	15 Phillips Street.
Pickard, Herbert Peirce,	Concord Junction,	17 Kellogg Avenue.
Priest, Atwood Wheeler,	North Vassalboro, Me.,	Mount Pleasant, care of C. R. Green.
Purdy, Donald Ring,	Waverley,	3 Eames Avenue.
Quinn, William Robert,	Natick,	35 North Prospect Street.
Quirk, William Joseph,	Waltham,	101 Pleasant Street.
Raymond, Matthew George,	Amherst,	Box 552.
Richards, Osgood Samuel,	Amherst,	5 School Street.
Robinson, Frederick Charles,	Westford,	17 Pleasant Street.
Robinson, Leo Victor,	Amherst,	North Amherst, care of J. Dowd.
Rodwaye, George Wildemere,	Amherst,	9 Gaylord Street.
Root, Howard Chapin,	Colerain,	15 Hallock Street.
Russell, Paul Belford,	West Medway,	9 Fearing Street.
Sanctuary, Alfred Everett,	Amherst,	196 South Pleasant Street.
Sawyer, John Henry,	North Brookfield,	Mount Pleasant, care of H. N. Worthley.
Sexton, John Welch,	South Boston,	6 Nutting Avenue.
Shaw, Charles Dudley,	Westfield,	120 Pleasant Street.
Shaw, Walter Bruce,	Sutton,	8 Kellogg Avenue.
Smith, Raymond Leslie,	East Hartford, Conn.,	East Experiment Station.
Smith, Sidney Alexander,	Worcester,	79 Pleasant Street.
Snelling, Samuel William,	Lincoln,	34 Pleasant Street.
Spinney, Joseph Warren,	Manchester,	East Experiment Station.
Spooner, Roy Adelbert,	Dorchester,	31 East Pleasant Street.
Spooner, William Danforth,	Brimfield,	61 Amity Street.
Spring, Earle Nelson,	Millers Falls,	20 Lessey Street.
Steele, Gordon Ells,	Waverley,	108 Pleasant Street.
Steele, Percy Howard,	Hopkinton,	101 Pleasant Street.
Talbot, William Joseph,	Amherst,	8 Hallock Street.
Taylor, Arthur Raymond,	Framingham,	East Experiment Station.
Thorn, Henry Holton,	Deerfield,	North Amherst.
Tipple, Albert Nelson,	Amherst,	15 Amity Street.
Trafton, Walter Richard,	Swampscott,	70 Lincoln Avenue.
Vartanian, Neshan,	Indian Orchard,	9 Fearing Street.
Veselak, Helen Clara,	Westfield,	Adams House.
Walsh, John, Jr.,	Bedford,	North Pleasant Street, Box 523.
Warner, Harry Freeman,	Wollaston,	83 Pleasant Street.
Waterman, Harry Lester,	South Thomaston, Me.,	70 Lincoln Avenue.
Watson, Alan Wendell,	Providence, R. I.,	17 Kellogg Avenue.
Whitcomb, Harold Adams,	Concord Junction,	Farview Way, care of J. K. Shaw.
White, Alice Louise,	Bristol, Conn.,	Adams House.
White, Ralph Harold,	Barnard, Vt.,	66 Pleasant Street.
Whitmore, Raymond Swett,	Arlington Heights,	3 Eames Avenue.
Wiggin, Herman Theron,	Norwood,	83 Pleasant Street.
Willson, Stewart Hemingway,	Thompsonville, Conn.,	75 Pleasant Street.
Wilson, Harvey William,	Boston,	Eastman Lane, Box 631.
Wood, Matthew Arnold,	South Portland, Me.,	73 Pleasant Street.
Young, George Thomas,	Wilkinsonville,	8 Kellogg Avenue.

First Year.

Adair, Eldred,	Boston,	President's House, M. A. C.
Adams, John,	New York, N. Y.,	18 Nutting Avenue.
Ahlstrom, Roger William,	East Milton,	9 Phillips Street.
Allen, Sidney Henry,	Lynn,	35 East Pleasant Street.
Arp, Richard Dietrich,	Amherst,	30 Cottage Street.
Belcher, Edgar Estes,	East Weymouth,	Care of E. F. Gaskill.
Bell, William T. A.,	Dorchester,	101 Pleasant Street.
Betterley, Guy William,	Brattleboro, Vt.,	70 Lincoln Avenue.
Bligh, Norman Francis,	Boston,	29 East Pleasant Street.
Blish, Stanley Frye,	Brookline,	9 Phillips Street.
Bosworth, Earl Kenneth,	North Orange,	5 Fearing Street.
Breivogel, Henry Adam,	Jamaica Plain,	4 Chestnut Street.
Bresnahan, John Francis,	Malden,	Colonial Inn.
Brown, Frederick Davis,	Webster,	32 North Prospect Street
Brown, Milton Shumway,	Templeton,	8 Kellogg Avenue.
Burke, James Andrew,	Dorchester,	3 North Prospect Street.
Cahill, Paul Bennett,	Waltham,	6 Nutting Avenue.
Carlsen, Lewis,	Gloucester,	35 North Prospect Street.
Carlson, Oscar,	Sweden,	66 Pleasant Street.
Castillo, Aristides Henry,	El Salvador, C. A.,	101 Pleasant Street.
Castillo, Joseph A.,	El Salvador, C. A.,	101 Pleasant Street.
Chamberlain, Bert N.,	Hudson,	25 North Prospect Street.
Clark, William Guster,	Amherst,	12 Beston Street.
Clifford, Lura Marion,	Boston,	Adams House.
Cluff, Victor Newton,	Dracut,	8 Kellogg Avenue.
Condon, Thomas Casey,	Medford,	25 North Prospect Street.
Convery, Edward Francis,	Charlestown,	47 North Pleasant Street.
Crossman, Laurence Stephens,	Springfield,	7 Nutting Avenue.
Crowell, Elbridge Hodgman,	Wollaston,	29 East Pleasant Street.
Cushman, John Kenneth,	Springfield,	8 Kellogg Avenue.
Davenport, Aris Elizabeth,	Dorchester,	Adams House.
David, James Vernon,	Amherst,	24 Belchertown Road.
DeLano, Wilbert Kilbourn,	Richmond Hill, N. Y.,	32 North Prospect Street.
Doane, Smith Eaton,	Worcester,	8 Kellogg Avenue.
Donovan, Albert Peter,	Canada,	36 North Prospect Street.
Downey, Francis William,	Boston,	34 Pleasant Street.
Erickson, Karl Henrich,	Somerville,	29 Lincoln Avenue.
Farrow, Henry Grindle,	Rockport, Me.,	70 Lincoln Avenue.
Fitzgerald, Edward John,	Fitchburg,	101 Pleasant Street.
Flagg, Nolan Randolph,	Worcester,	12 McClure Street.
Flaherty, Martin Robert,	Wamesit,	50 Lincoln Avenue.
Fletcher, Robert Longard,	Stow,	70 Lincoln Avenue.
Galbraith, Hermon William,	South Hadley,	15 Hallock Street.
Gamage, John Carter,	Portland, Me.,	27 Fearing Street.
Gauthier, Francis Joseph,	Boston,	36 North Prospect Street.
Geremonty, Francis Howard,	Stoneham,	101 Pleasant Street.
Gokey, Emery,	Rutland, Vt.,	17 Phillips Street.
Grant, Nelson Atherton,	Indian Orchard,	Box 114, North Amherst.
Green, George Alex,	Cambridge,	18 Nutting Avenue.
Griffin, Charles Mathew, Jr.,	Westford,	15 Hallock Street.
Grimes, George Robert,	Nantucket,	40 Mount Pleasant.
Gustafson, Gustaf Albert,	Wilmington,	Care of M. W. Hoyt, North Amherst.
Hamilton, Weston Alexander,	Salem,	13 Phillips Street.
Harrington, Walter Peck,	North Amherst,	Meadow Street.
Harrington, William John,	Rutland, Vt.,	Box 77, North Amherst.
Harrison, Nicholos Peter,	London, Eng.,	45 Pleasant Street.
Hartwell, John Rodman,	Lincoln,	3 Eames Avenue.
Hasbrook, Stephen Leaybron, Jr.,	Amherst,	Baker Street.
Hasbrouck, Ethel Edwards,	Amherst,	5 Paige Street.
Headberg, Axel Edward,	West Somerville,	116 Pleasant Street.

Heald, Edwin Tracy,	Ashburnham,	6 Maple Avenue.
Hibbard, Perley,	Dedham,	31 East Pleasant Street.
Hurd, Merton Bartlett,	Spencer,	4 Chestnut Street.
Jacomb, Constance Lucy,	Groton,	Adams House.
Jaeckle, Matthew Laurence,	Nantucket,	40 Mount Pleasant.
Joe, James Balmain,	East Milton,	34 Pleasant Street.
Jordan, Llewellyn Powers,	Bar Harbor, Me.,	8 Kellogg Avenue.
Keating, Joseph Michael,	Willimansett,	4 Chestnut Street.
Keirstead, Ralph Ramsay,	Worcester,	4 Chestnut Street.
Keith, George Robert,	West Boylston,	29 Lincoln Avenue.
Kemble, Winslow,	Marblehead,	21 Fearing Street.
Kessili, Howard Maxwell,	Worcester,	12 McClure Street.
Kinder, Laurence Philip,	Saxonville,	51 Amity Street.
Knight, Allen, Jr.,	Amherst,	29 East Pleasant Street.
Knightly, George Thomas,	Amherst,	12 Clifton Avenue.
Kohlrausch, George Edwin,	Chelsea,	2 McClellan Street.
Labrovitz, Max Browdy,	Amherst,	11 Amity Street.
Leavitt, Dorothy Wilmer,	Whitman,	Adams House.
LeBallister, Ralph Hammond,	Concord,	16 Amity Street.
Lincoln, Edward Joshua,	Spencer,	35 East Pleasant Street.
Lolley, Horace Jim,	Pelham,	Harkness Road, Box 134.
Loring, Frank Sumner,	Gloucester,	35 North Prospect Street.
Maggi, Joseph Francis,	Holyoke,	4 Chestnut Street.
Mans, Charles William,	South Royalton, Vt.,	18 Nutting Avenue.
Margreve, Frederick Nicholas,	Cambridge,	53 Lincoln Avenue.
Markham, Albert Gallitin,	Springfield,	North Amherst.
McKenna, George Earle,	Orange,	36 North Prospect Street.
McKenna, Philip James,	Hyde Park,	47 Chestnut Street.
Moore, Lloyd Weymouth,	Worcester,	McClure Street.
Motyka, John Joseph,	Amherst,	26 Cottage Street.
Nettleton, Francis Irving, Jr.,	Shelton, Conn.,	13 Fearing Street.
Norton, Frances Close,	Salisbury, Conn.,	Adams House.
Packard, Marjory Emma,	Ashfield,	Adams House.
Palmer, Justin,	Lowell,	Baker Place.
Parsons, Howard Joel,	Conway,	13 Fearing Street.
Partenoff, Christo,	Middleborough,	36 North Prospect Street.
Perry, Gardner, Jr.,	Dedham,	3 McClellan Street.
Pollock, Gordon Standley,	Salem,	12 McClure Street.
Powell, Katharine Leslie,	Boston,	Adams House.
Power, Maurice Joseph,	Amherst,	36 North Prospect Street.
Prescott, William H.,	Holyoke,	8 Kellogg Avenue.
Preston, John Dabney Stuart,	Wytheville, Va.,	8 Kellogg Avenue.
Ramsdell, Kenneth Hammond,	Southville,	116 Pleasant Street.
Ripley, David Hamilton,	Blandford,	27 Fearing Street.
Ritchie, Harry Ellsworth,	Rutland, Vt.,	North Amherst, Box 77.
Robinson, George Sutherland,	Lynn,	25 North Prospect Street.
Ross, Ian Hamilton,	New York, N. Y.,	66 Pleasant Street.
Russell, Byron Roberts,	Brimfield,	30 North Prospect Street.
Russell, Elizabeth F.,	Boston,	Adams House.
Sanford, Paul Reed,	Stamford, Vt.,	56 Main Street.
Sargent, Edna May,	Chelmsford,	Adams House.
Savcheff, Andrew,	Springfield,	56 Pleasant Street.
Sayles, Arthur Updike,	Providence, R. I.,	3 Pleasant Street.
Schlitz, Henry,	Northampton,	52 William Street, Northampton.
Seaver, Harold Davidson,	Agawam,	84 Pleasant Street.
Sherwood, Joseph Morgan,	Huntington,	17 Kellogg Avenue.
Slate, Herbert Taylor,	Bernardston,	21 Fearing Street.
Smith, Willard Stevenson,	Westboro,	35 East Pleasant Street.
Sprague, Morrill Goodwin,	Harvard,	18 Nutting Avenue.
Standley, Wallace,	Middleton,	29 Lincoln Avenue.
Stuart, Frances Elizabeth,	Bangor, Me.,	Adams House.
Sullivan, Joseph Stephen,	Holyoke,	56 Pleasant Street.

Sullivan, Patrick William,	Amherst,	54 Cottage Street.
Sutton, Samuel Carleton,	Needham,	101 Pleasant Street.
Thompson, Burton Elmer,	West Somerville,	21 Amity Street.
Thouin, Faina Gladys,	Easthampton,	Adams House.
Tompkin. Harry Wilson,	Newton Upper Falls,	44 High Street.
Tyzzer, Gerald Edwards,	Wakefield,	41 Lincoln Avenue.
Vaber, John Edward,	Lee,	North Amherst.
Wells, Alphonsus,	Malden,	12 Beston Street.
Wheeler, John Walter,	Cooperstown, N. Y.,	15 Fearing Street.
Whidden, Ralph Edward,	Amherst,	East Pleasant Street.
White, Donald Mitchell,	Winthrop,	5 Nutting Avenue.
Wholly, Roger Timothy,	Cambridge,	North Amherst.
Willet, Frederick William,	Lowell,	16 Amity Street.
Williams, Archie,	Westfield,	84 Pleasant Street.
Wilson, Frank Edward,	Warren,	5 Nutting Avenue.
Wilson, Harold Elton,	Graniteville, Vt.,	15 Phillips Street.
Woodward, Paul Nelson,	Princeton,	15 Hallock Street.
Woodworth, Ralph Merrill,	Rowley,	17 Kellogg Avenue
Worthley, James Everett,	Wakefield,	Care of H. N. Worthley, Mount Pleasant.
Wyman, Francis,	Medford,	17 Kellogg Avenue.

VOCATIONAL POULTRY COURSE, 1920–21.

Adams, David Lloyd,	Springfield,	Hillside Avenue, R. F. D. 126.
Ashforth, Arthur Clifton,	Brockton,	Poultry Department, M. A. C.
Bartholomew, Francis Michael,	Amherst,	13 Amity Street.
Beaulieu, Frederick Armond,	North Attleborough,	9 Gray Street.
Brown, Joseph Harry,	Killingly, Conn.,	1 Pease Avenue.
Corcoran, James Joseph,	Boston,	36 North Prospect Street.
D'Amelio, George,	Milford,	35 East Pleasant Street.
Davis, John Andrew,	Amherst,	13 Amity Street.
Dinneen, Walter James,	Revere,	101 Pleasant Street.
Fournier, Arthur,	Hawley,	1 Pease Avenue.
Hunter, Charles O.,	Stoneham,	R. F. D. 126.
King, Robert Ferris,	Amherst,	5 Hitchcock Street.
Leonard, John Francis,	Amherst,	47 Chestnut Street.
McCave, Herbert William,	Boston,	116 Pleasant Street.
McHugh, John Edward,	New Bedford,	27 Fearing Street.
O'Brien, Charles Pierce,	Everett,	35 North Prospect Street.
Parsons, Norman Chester,	Everett,	9 Gray Street.
Richards, Isaac,	Longbeach, Cal.,	27 Fearing Street.
Whitford, Ralph Collins,	Lowell,	20 Lessey Street.

WINTER SCHOOL, 1920.

Adams, Alpheus R.,	Northborough.
Adjeleian, Harry,	Worcester.
Allen, Mrs. Caleb D.,	Williamsburg.
Allen, Caleb D.,	Williamsburg.
Allen, Ralph C.,	Longmeadow.
Allison, Nathan K.,	Granby, Conn.
Baldwin, Kenneth L.,	Wilton, N. H.
Barton, Elmer B.,	Keene, N. H.
Barton, Harold J.,	Keene, N. H.
Bertucio, Steven,	Fitchburg.
Bishop, Chas. R.,	Guilford, Conn.
Blanchard, Clifford B.,	Abington.
Boothby, Richard P.,	Dorchester.
Bradley, Dean H.,	Ilion, N. Y.
Brown, Howard B.,	Dunstable.

Butler, Frank H.,	– –
Camp, Emily B.,	Norwich, Conn.
Carlson, Ralph H.,	Springfield.
Cartwright, Calton O.,	Northampton.
Chace, Maude,	Providence, R. I.
Chaffee, Norman F.,	Oxford.
Chapel, Walter,	Bolton.
Chappell, Simon,	Boston.
Cleare, Lawrence,	East Milton.
Cobb, Chas. E.,	– –
Cobb, Mary C.,	– –
Conroy, Annie,	New Bedford.
Cook, Ashley L.,	Hadley.
Cooley, Burton L.,	Granville Center.
Cornwall, Lester W.,	Medway.
Cowan, Elisabeth B.,	Amherst.
Craig, Dexter H.,	Plymouth.
Crowell, Marcus L.,	East Dennis.
Deutsch, Miriam,	Baltic, Conn.
Emerson, Helen,	Providence, R. I.
Exley, Lucius M.,	Plainfield, Conn.
Filer, Walter S.,	South Hadley Falls.
Fiske, Wm. M.,	Amherst.
Fitzmorris, Joseph,	Whitfield, N. H.
Forbes, Alice H.,	Milton.
Grant, Grace,	Sharon.
Greene, Robert A.,	Vinalhaven, Me.
Grover, Alonzo P.,	Rockport.
Gustin, B. F.,	North Amherst.
Haig, John B.,	Chicopee Falls.
Hall, Helen,	Milton.
Harris, Harry E.,	Methuen.
Hart, Adrian P.,	Cambridge.
Hart, Albert B.,	Cambridge.
Hayes, Geo. F.,	Tariffville Center, Conn.
Hofer, Chas. E.,	Zurich, Switzerland.
Howard, Marguerite F.,	Danvers.
Howard, Ralph W.,	Worcester.
Hubbard, Leland T.,	Middletown, Conn.
Hunt, Donald R.,	Newtonville.
Ives, William F.,	Amherst.
Jacobs, Albert F.,	Dudley.
Jacobson, Victor J.,	Dorchester.
Joy, Henry F.,	Hartford, Conn.
Knowles, Frank P.,	Dorchester.
Ladd, Chas. P.,	Pike, N. H.
Landstrom, Oscar N.,	Heath.
Lerner, Harry N.,	Peru.
LeValley, Sarah H.,	Hope, R. I.
Lord, Reginald L.,	Lyme, Conn.
Lowry, Floyd P.,	Williamstown.
MacRae, Rena N.,	Wilmington, N. C.
McGrath, Elsie,	Rockport.
Nelson, Carl A.,	Roslindale.
Nye, Henry C.,	Springfield.
Olds, George W.,	Middlefield.
Ostrander, George B.,	Auburn, N. Y.
Otterbein, Wm. Lewis,	Orange, N. J.
Perrins, Wm. A.,	Jamaica Plain.
Pollard, LeRoy H.,	New Braintree.
Poor, Nathan H.,	Danvers.
Porter, Philip C.,	West Springfield.
Prentiss, Bertha H.,	Holyoke.
Ramsey, Samuel,	Boston.

Reid, Hay B.,	Osterville.
Robinson, Eben G.,	Edgewood, R. I.
Robinson, Eva M.,	Petersham.
Samson, Josephine,	Greenfield.
Sanders, Hector G.,	South Boston.
Scandrett, Jay M.,	Highwood, N. J.
Schatz, Phœbe,	Yantic, Conn.
Simpson, Geo. W.,	Wallingford, Conn.
Skillings, Susan C.,	Amherst.
Sliter, Oscar R.,	Montague.
Spofford, Fred R.,	Georgetown.
Stearns, Horace D.,	Waltham.
Stocking, Albina M.,	Springfield.
Stocking, James F.,	Springfield.
Strang, James H.,	Clinton.
Sullivan, Raymond J.,	Bondsville.
Sutton, Lawrence,	Plainfield, N. J.
Tent, James,	Hatchville.
Tilton, E. B.,	Boston.
Townsend, Ethelyn,	Cambridge.
Tufts, James W.,	South Amherst.
Upham, Ray D.,	Florence.
Wheeler, Sol C.,	Litchfield, Conn.

Professional Improvement Course for Teachers, January, 1920.

Two Weeks.

Glover, Theodore Whitford,	North Easton.
Harvey, Samuel Hugh,	Brimfield.
Houston, A. G. Arthur,	West Springfield.
Howard, Ernest Albert,	Peabody.
Loring, William Rupert,	Great Barrington.
Lundgren, Robert Arthur,	Orange.
Mayo, William Irving, Jr.,	Plymouth.
Mitchell, Robert Ambrose,	Danvers.
Salter, James,	Walpole.
Tomlinson, Bertram,	Concord.

Summer Sessions, 1920.

Four and Six Weeks' School.

Abbott, Florence I.,	Andover.
Acton, Kathryn I.,	Framingham.
Acton, Sara V.,	Framingham.
Adams, Clarice M.,	Colrain.
Adams, Esther F.,	West Warren.
Adams, Sarah A.,	Hardwick.
Alley, Evelyn L.,	Hyde Park.
Archer, Mary E.,	Salem.
Argood, Roy T.,	Walpole.
Arp, Esther W.,	Amherst.
Atkins, May L.,	Charlemont.
Bailey, Ritie L.,	East Deerfield.
Ball, Lorin E.,	Amherst.
Barker, Marjorie,	Amherst.
Barney, Laura E.,	Amherst.
Berman, Dora,	Holyoke.
Bicknell, Robert W.,	Newton Highlands.
Boorn, Eloise H.,	Adams.
Bowen, Harriet A.,	Fall River.
Brennan, Ellen G.,	Bradstreet.
Britton, Carrie G.,	Springfield.
Buchanan, Walter G.,	Chicopee.

Butterworth, Carolyn E.,	Amherst.
Camp, Emily B.,	Norwich, Conn.
Chace, Sarah M.,	Brookline.
Chapin, Marguerite,	Florence.
Clark, Dorothy P.,	Newton.
Cloroty, Nellie A.,	Brockton.
Coe, Alice E.,	Southampton.
Coffin, Charlotte,	Dorchester.
Coleman, Carl L.,	Winsted, Conn.
Coolidge, Lucy L.,	Wollaston.
Cooper, Gladys V.,	Athens, Pa.
Corey, Eva L.,	Amherst.
Coyle, Agnes H.,	Fall River.
Coyle, Florence K.,	Fall River.
Crafts, Eleanor E.,	Whately.
Crockett, Grace F.,	Pomfret, Vt.
Cronan, Alice E.,	Chicopee.
Cross, Mazie E.,	Chester.
Curtis, Betsey P.,	Gloucester.
Dalton, Mary E.,	Northfield.
Daniels, Agnes E.,	Worcester.
Danskin, Edith L.,	Melrose Highlands.
Davis, Elizabeth I.,	Taunton.
Davison, Paula H.,	Laporte, Ind.
Day, Laura G.,	Warren.
Day, Marion L.,	Warren.
Dickinson, Ame S.,	Amherst.
Doane, Delia S.,	Wallingford, Conn.
Dorntee, Marie L.,	Arlington.
Dwight, Susan H.,	Griswoldville.
Emerson, Louise K.,	Braintree.
Fairman, Frances L.,	Amherst.
Faneuf, Helen S.,	Lowell.
Farley, Alice J.,	Boston.
Farrar, Harry A.,	Middleton.
Farrell, Albert L.,	Worcester.
Fisk, Emma W.,	Charlemont.
Fitman, Anna G.,	Worcester.
Flaherty, Marguerite A.,	Hadley.
Flaherty, Mary E.,	Hadley.
Flynn, Elizabeth C.,	Malden.
Follette, Miriam A.,	Great Barrington.
Fox, Kathryn B.,	Athol.
Frellick, Arthur L.,	Everett.
Frellick, Ralph S.,	Everett.
Gardner, Blanche,	Northampton.
Gifford, George E.,	Middleton.
Gifford, John E.,	Sutton.
Glazier, Leta M.,	Amherst.
Gleason, Grace E.,	North Heath.
Glynn, Leo D.,	East Longmeadow.
Graves, Benjamin R.,	Northampton.
Graves, Stephen M.,	New London, Conn.
Greene, Jessie M.,	Marlborough.
Greene, Louise D.,	Boston.
Hall, Helen,	Milton.
Hamblett, Florence I.,	Attleboro.
Hamblett, Marion S.,	Attleboro.
Harrington, Carrie B.,	Amherst.
Harrington, Mary L. V.,	Fall River.
Haven, Viola E.,	Athol.
Hickey, Charles,	Cushman.
Holliday, Rebecca F.,	Boston.
Horr, May E.,	North Prescott.

Houghton, Irene V.,	Brockton.
Howard, Anne R.,	Braintree.
Howlett, Cora M.,	South Amherst.
Hunt, Blanche L.,	Charlemont.
Jarrett, Thomas D.,	Preston, Va.
Kingsley, Marjorie A.,	Monroe Bridge.
Kroeck, Julius, Jr.,	Huntington, N. Y.
Lavalette, Edith A.,	Malden.
Linehan, Mary L.,	Amherst.
Lomax, Maud H.,	Washington, D. C.
Loomis, Elsie M.,	Ashland.
Lord, Marguerite L.,	Petersham.
Lou, Chang H.,	Tientsin, China.
Luke, Myra D.,	Amherst.
Lynch, Alexander J.,	Fitchburg.
Mallorey, Alfred S.,	East Lynn.
Maxwell, Robert W.,	Woodstock, N. B., Can.
McHugh, Catharine A.,	Worcester.
McIntire, Mary M.,	Salem.
Monahan, Christine H.,	Shelburne Falls.
Monteith, Agnes M.,	Natick.
Montesanto, John E.,	Melrose.
Mooney, Miles,	Worcester.
Moore, Margaret B.,	Amherst.
Moriarty, Mary T.,	Greenwich, Conn.
Murphy, Agatha,	Brookline.
Nakagawa, Hisamoto,	Tokyo, Japan.
Neill, Jessie A.,	Amherst.
Nelson, Dora E.,	Greenfield.
Newlon, Charlotte R.,	Amherst.
Newton, Clara W.,	Amherst.
Nixon, Leonard R.,	Exeter, N. H.
Norrington, Ruth O.,	Amherst.
Nowlan, Elizabeth T.,	Amherst.
Nugent, Gertrude V.,	Boston.
O'Brien, Helen A.,	Westfield.
O'Brien, Katherine M.,	Dorchester.
Park, Emma F.,	Mittineague.
Parsons, Elgie R.,	Northampton.
Patterson, Beulah E.,	Amherst.
Paul, Eva J.,	Shelburne Falls.
Perkins, Myrtle J.,	Shelburne Falls.
Prand, Catherine,	Roxbury.
Prand, Rosa M.,	Roxbury.
Quimby, Cora M.,	Amherst.
Ray, Ruth E.,	Amherst.
Richards, Doris,	Orange.
Richards, Viola F.,	South Deerfield.
Richards, Vivian B.,	Orange.
Ricks, Launard E.,	Amherst.
Robbins, Mildred J.,	Amherst.
Rodwaye, Ruth L.,	Amherst.
Russell, Ruth H.,	Northborough.
Ryan, Teresa,	Fall River.
St. George, Augustin,	Chicopee.
Sanctuary, William C.,	Amherst.
Sanford, Alice P.,	Newark, N. J.
Schneider, Katherine A.,	Great Barrington.
Scott, Nina F.,	Worcester.
Shaw, G. Eleanor,	Woburn.
Shaw, George J.,	Lucknow, India.
Sheridan, Katharine E.,	Wellesley Hills.
Sidney, Luella C.,	Wakefield.
Skillings, Susan H.,	Amherst.

Smart, Harold W.,	Amherst.
Smith, Emily D.,	Amherst.
Smith, Irene I.,	Somerville.
Spencer, Miriam I.,	Springfield.
Staebner, Emerson,	Willimantic, Conn.
Stowell, Harold T.,	New Salem.
Stowell, Margaret B.,	New Salem.
Stratton, Alice I.,	Framingham.
Sullivan, Mary D.,	Fall River.
Sumner, Margaret L.,	Braintree.
Suprenant, Valmore J.,	Adams.
Swain, Caroline M.,	Wilmington.
Swain, Henrietta A.,	Wilmington.
Thompson, Lulu B.,	West Somerville.
Titus, Alice H.,	Mittineague.
Twiss, Marion D.,	Worcester.
Upham, Esther N.,	Melrose.
VanPiper, Susie,	South Hadley Falls.
Verder, Bessie C.,	Mattapoisett.
Verder, Daniel H.,	Mattapoisett.
Walsh, Bertha H.,	Amherst.
Wang, Hsin Y.,	Tientsin, China.
Ward, Vivian I.,	Buckland.
Warren, Helen A.,	Grafton.
Wells, Reuben F.,	Hatfield.
Wheeler, Dorothy L.,	Bardwells Ferry.
Whitlock, Mildred W.,	Cleveland, Ohio.
Whitney, Jennie M.,	North Adams.
Wilde, Cora L.,	Fall River.
Wilde, Mildred F.,	Fall River.
Wilkes, Dorothy E.,	Bridgeport, Conn.
Wilkes, Otis R.,	Bridgeport, Conn.
Williams, Etta L.,	Southampton.
Wright, Gladys H.,	Watertown.
Wright, Nina K.,	Bellows Falls, Vt.
Zass, Anna I.,	Holyoke.

Eight Weeks' Summer School for Two-year Students.

Allen, Chester C.,	Amherst.
Atwood, Carl S.,	Medford.
Barney, Ernest W.,	Amherst.
Bartholemew, Francis M.,	Boston.
Boland, Albert M.,	Worcester.
Breen, Arthur J.,	Granby.
Brooker, John P.,	Roxbury.
Burke, Leslie J.,	Medford.
Cady, Howard M.,	South Shaftsbury, Vt.
Christensen, Frank W.,	North Easton.
Clarke, William J.,	Ipswich.
Colleary, Thomas P.,	Revere.
Connelly, Leo A.,	Waltham.
Corcoran, James J.,	Boston.
Corey, Raymond S.,	Amherst.
Crocker, Fred C.,	Amherst.
Daisy, Walter E.,	Roslindale.
Davis, John A.,	Cambridge.
Dunleavy, Henry J.,	Boston.
Finn, William F.,	Chelsea.
Flynn, Harry J.,	Bennington, Vt.
Gallant, Daniel J.,	Gloucester.
Gamage, John C. F.,	Portland, Me.
Gaudette, Claude I.,	Amherst.
Graeff, Charles A.,	New York, N. Y.

Graumann, Lewis M.,	Roxbury.
Hartling, Wilfred L.,	Boston.
Hastings, John V.,	Amherst.
Hayden, Arthur L.,	Natick.
Igo, Bernard J.,	West Somerville.
Jacques, John W.,	Malden.
Jordan, Lewellyn P.,	Bar Harbor, Me.
Judge, Clarence P.,	Raynham.
Kaveney, Francis E.,	Hyde Park.
Knight, Henry E.,	Easton, Me.
Lawton, Edgar L.,	Brattleboro, Vt.
Lincoln, Leon P.,	Barre.
Lolley, Horace J.,	Pelham.
Lounsbury, Francis E.,	Cambridge.
Macomber, Donald A.,	Springfield.
Magoon, Austin W.,	Greensborobend, Vt.
Mayne, Joseph J.,	Brookline.
McHugh, John E.,	New Bedford.
Morse, Herbert E.,	Foxborough.
Mullen, Frank M.,	Fayville.
Narkin, Isadore,	Brockton.
Norrington, Henry,	Amherst.
Oakes, John J.,	Wellesley.
O'Brien, Charles P.,	Everett.
Olson, Nils T.,	Dorchester.
O'Neal, Fred,	Yakima, Wash.
Parent, Ely A.,	Springfield.
Pellis, Abraham,	Chelsea.
Priest, Atwood W.,	North Vassalboro, Me.
Quirk, William J.,	Waltham.
Raymond, Matthew G.,	Amherst.
Richards, Isaac,	Springfield.
Richards, Osgood S.,	Amherst.
Robinson, Leo V.,	Athol.
Rodwaye, George W.,	Amherst.
Savage, John F.,	Boston.
Sexton, John W.,	South Boston.
Steele, Percy H.,	Hopkinton.
Talbot, William J.,	Amherst.
Tipple, Albert N.,	Amherst.
Walsh, John, Jr.,	Bedford.
Waterman, Harry L.,	South Thomaston, Me.
Whitbeck, Henry,	Amherst.
White, Ralph H.,	Barnard, Vt.
Wilson, Harold E.,	Graniteville, Vt.
Wilson, Harvey W.,	Boston.

Eight Weeks' Summer School for Unit-course Students.

Adams, Lawrence Ware,	Swampscott.
Arp, Dietrich,	Amherst.
Bentley, George Carter,	Osterville.
Berry, Alverdo Dodge,	Melrose.
Brown, Joseph Harry,	Killingly, Conn.
Carlson, Oscar,	Sweden.
Chrisfield, Edward Richardson,	Needham.
Clark, William Guster,	Amherst.
Costos, Charles Nicholas,	Brookline.
Coughlin, John Harold,	Beverly.
Coupard, Louis,	East Lexington.
Coury, Hatem Majim,	Springfield.
Crehan, Owen Joseph,	Onset.
Crowell, Bernard,	Amherst.
D'Amelio, George,	Milford.

Donovan, Albert Peter,	Canada.
Fazio, Charles Edward,	Springfield.
Fournier, Arthur George,	Hawley.
Frappier, Victor Edward,	Proctor, Vt.
Gauthier, Francis Joseph,	Boston.
Gavett, George Billings,	South Portland, Me.
Gibbons, William Frank,	Fitchburg.
Gokey, Emery,	Rutland, Vt.
Good, William John,	Milo, Me.
Gustafson, Gustaf Albert,	Wilmington.
Hagan, Patrick,	Cambridge.
Hall, John Robert,	South Boston.
Hamilton, Weston Alexander,	Salem.
Hardy, John Joseph,	Everett.
Hemond, Edward Joseph,	Willimansett.
Herbert, John Edward, Jr.,	Everett.
Hulcup, William,	Riverside, R. I.
Hunter, Charles Otis,	Stoneham.
Irby, Daniel Harmon,	Gardiner, Me.
Jordan, Emmett Philmore,	Smithfield, Va.
Kane, Daniel,	Boston.
Kelley, Patrick Leo,	Boston.
Knight, Allen, Jr.,	St. Johnsbury, Vt.
Koloski, William Aloysius,	Three Rivers.
Komla, Stanley,	Cambridge.
Kovachovich, John Joseph,	Boston.
Kruk, John Alexander,	South Deerfield.
Leonard, John Francis,	Newton.
Libby, George Amos,	Sheffield, Vt.
Marino, Guiseppe,	Boston.
Mason, Edwin Clark,	Charlestown.
McCave, Herbert William,	Boston.
McEntre, James Frederic,	Boston.
McKenna, Philip James,	Hyde Park.
Moczarski, Joseph,	Holyoke.
Motyka, John Joseph,	Lowell.
Partenoff, Christo,	Middleborough.
Perry, Louis,	Peabody.
Puopolo, Salvatore,	Boston.
Riley, Joseph Frederick,	Stoneham.
Robinson, Edward George,	Springfield.
Sadowski, Stephan Anthony,	South Boston.
Sandy, James Anderson,	Worcester.
Trebeck, Thomas,	Springfield, Vt.
Tronzo, Herbert,	Rutland, Vt.
Tucker, Newton Elmer,	Cambridge.
Unwin, Edward,	East Dedham.
Whidden, Ralph Edward,	Amherst.
Whitford, Ralph Collins,	Lowell.
Wolf, Henry,	Shirley.

Unit Course, September, 1920.

Allen, Sidney Henry,	Lynn,	56 Pleasant Street.
Benson, John Melvell,	Mt. Desert, Me.,	– –
Bentley, George Carter,	North Reading,	56 Pleasant Street.
Bullock, James,	Bristol, R. I.,	4 Chestnut Street.
Bushey, William Francis,	Ashuelot, N. H.,	– –
Carroll, Charles Raymond,	Stoneham,	9 Amity Street.
Clark, Leon Leathe,	Plymouth, N. H.,	21 Northampton Road.
Clouthier, Edward,	Brunswick, Me.,	36 North Prospect Street.
Considine, Francis Anthony,	Watertown,	116 Pleasant Street.
Costos, Charles Nicholas,	Brookline,	15 Phillips Street.
Coupard, Louis,	Lexington,	47 Chestnut Street.

Coury, Hatem Majim,	Springfield,	56 Pleasant Street.
Crehan, Owen Joseph,	Roxbury,	4 Chestnut Street.
Crowell, Bernard,	North Amherst,	Meadow Street.
Danske, Frank,	Holyoke,	Triangle Street.
Devio, Alexander Leo,	North Amherst,	Summer Street.
Dunbar, Albert Jarvis,	Greenwood, R. I.,	4 Chestnut Street.
Fazio, Charles Edward,	Springfield,	75 Pleasant Street.
Gavett, George Billings,	South Portland, Me.,	5 McClellan Street.
Gibbons, William Frank,	Fitchburg,	120 Pleasant Street.
Hagan, Patrick,	Cambridge,	4 Chestnut Street.
Haley, William Howard,	Malden,	3 Pleasant Street.
Hemond, Edward Joseph,	Willimansett,	56 Pleasant Street.
Herbert, John Edward, Jr.,	Everett,	18 Nutting Avenue.
Holden, Robert Miller,	Melrose Highlands,	18 Walnut Street.
Irby, Daniel Harmon,	Amherst,	4 Chestnut Street.
Johnson, Carl Eugene,	Gloucester,	3 Nutting Avenue.
Jordan, Emmett Philmore,	West Medford,	101 Pleasant Street.
Keller, Earle Franklin,	Augusta, Me.,	3 Eames Avenue.
Koloski, William Aloysius,	Springfield,	116 Pleasant Street.
Komla, Stanley,	Cambridge,	Triangle Street.
Kovachovich, John Joseph,	Boston,	69 Main Street.
Kruk, John Alexander,	South Deerfield,	South Deerfield.
Lagimoniere, Ernest,	Montague City,	41 Pleasant Street.
Libby, George Amos,	Ware,	30 Cottage Street.
Marino, Guiseppe,	Boston,	56 Pleasant Street.
Mason, Edwin Clark,	Charlestown,	41 East Pleasant Street.
Peters, Lawrence,	Kearsarge, N. H.,	3 Pleasant Street.
Roy, Leon Joseph,	Lawrence,	9 Amity Street.
Sadowski, Stephen,	Boston,	35 East Pleasant Street.
Sandy, James Anderson,	Worcester,	3 Nutting Avenue.
Shulver, Arthur,	Pawtucket, R. I.,	36 Pleasant Street.
Silvi, Mariano,	Providence, R. I.,	35 East Pleasant Street.
Stevenson, John,	Worcester,	4 Chestnut Street.
Trebeck, Thomas,	Springfield, Vt.,	4 Chestnut Street.
Tucker, Newton Elmer,	Cambridge,	21 Amity Street.
Unwin, Edward,	Amherst,	26 Cottage Street.
Wadman, Loran Wood,	Medford,	4 Chestnut Street.
Walsh, William Harold,	Jamaica Plain,	3 Pleasant Street.
Wolf, Henry,	Shirley,	4 Chestnut Street.

Unit Courses, prior to September, 1920.[1]

Babre, Charles Ivan,	Carmi, Ill.
Bjurman, Carl Axel,	Worcester.
Blomstrom, Ernest A.,	Providence, R. I.
Capaul, Jacob,	Roxbury.
Carroccia, Albert,	Providence, R. I.
Chamberlin, Gordon Sanford,	Everett.
Conroy, Maurice,	New Bedford.
Conway, Leo James,	Forest Hills.
Crawford, James Francis,	Springfield.
Dupuis, George Joseph,	Leominster.
Dutra, Philip Augustus,	Somerville.
Foy, James Patrick,	Roxbury.
Greenfield, Abraham,	– –
Harvey, Clarence Walter,	Somerville.
Kiely, Thomas Joseph,	– –
Lufkin, Harry Edward,	Somerville.
Mercer, Richard William,	New Bedford.
Perry, Jesse N.,	Boston.
Pettee, John Thomas,	Medford.

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[1] List does not include those who entered and stayed through the summer session.

Proctor, Fred,	Middlebury, Vt.
Ruzzanenti, Joseph,	Milford.
Sevigny, Eugene,	Dorchester.
Shaw, Earle B.,	Medford.
Vaillancourt, Wilfred Joseph,	Lawrence.

STUDENTS REGISTERED AFTER THE CATALOGUE OF 1919 WAS PUBLISHED.

Two-year Course.

Briggs, Leslie Frank,	Fitchburg.
Cedar, Harry,	– –
Coye, James Edward,	Waltham.
Fanning, Raymond Vincent,	Everett.
Fannon, Edwin Harvey,	Natick.
Foote, Clarence Edward,	Stratham, N. H.
Gately, James Joseph,	Cambridge.
Hubbard, James Sumner,	Sunderland.
Lasker, Samuel,	Providence, R. I.
Lee, Ralph Waldo,	Cambridge.
Lynch, Rodman Henry,	Malden.
Marnell, Patrick Leo,	Harrisville, N. H.
Oldfield, Amos William,	Auburndale.
Rand, Fred James,	Wayland.
Robinson, Benjamin,	Springfield.
Shirtcliff, Samuel Michael,	Montague City.
Swetland, Harvey Butler,	Agawam.
Willard, John Bradford,	Worcester.

Vocational Poultry Course.

Smith, Royce Walter,	Boston.

Rural Engineering Course.

Aubin, Joseph Octave,	Keene, N. H.
Stone, Archie Wallace,	North Hero, Vt.

SUMMARY OF SHORT COURSE ENROLLMENT.

	Men.	Women.	Total.
Two-year Course, second year,	125	10	135
Two-year Course, first year,	130	12	142
Vocational Poultry Course,	19	–	19
Winter School, 1920,	90	22	112
Summer Sessions, 1920: —			
Four and Six Weeks' School,	36	150	186
Eight Weeks' School for Two-year Students,	71	–	71
Eight Weeks' School for Unit-course Students,	65	–	65
Unit Courses, September, 1920,	50	–	50
Unit Courses, prior to September, 1920,	24	–	24
Totals,	610	194	804
Counted twice,	100	–	100
Totals,	510	194	704

INDEX

INDEX.

PAGE
Admission to the college, 29
Awards and prizes, 195
Calendar, 1920, 1921, 1922, 9
Clerical staff, 22
Corporation of the college, 14
Courses of instruction: —
  Agricultural Chemistry, 57
  Agricultural Economics, 61
  Agricultural Education, 62
  Agriculture, 45
  Agronomy, 47
  Animal Husbandry, 48
  Dairying, 49
  Economic Botany, 56
  Economic Entomology, 58
  Floriculture, 51
  Forestry, 52
  Freshman, 40
  Junior, 44
  Landscape Gardening, 53
  Majors, 44
  Microbiology, 59
  Pomology, 54
  Poultry Husbandry, 50
  Rural Journalism, 60
  Rural Sociology, 63
  Senior, 44
  Sophomore, 42
  Vegetable Gardening, 55
Degrees conferred in 1920, 199
Description of courses, 67
  Agricultural Economics, 129
  Agricultural Education, 132
  Agronomy, 67
  Animal Husbandry, 69
  Botany, 92
  Chemistry, 96
  Dairying, 71
  Drawing, 91
  Economics and Sociology, 117
  Entomology, 100
  Farm Management, 73
  Floriculture, 79
  Forestry, 81
  French and Spanish, 123
  Geology, 114
  German and Music, 126
  Heating, Lighting and Power, 111
  History and Government, 118
  Home Economics, 137
  Horticultural Manufactures, 83
  Horticulture, 84
  Landscape Gardening, 84
  Language and Literature, 119
  Mathematics and Civil Engineering, 104

PAGE
Description of courses — *Concluded.*
  Microbiology, 106
  Military Science, 139
  Physical Education, 142
  Physics, 110
  Pomology, 86
  Poultry Husbandry, 74
  Public Speaking, 122
  Rural Engineering, 76
  Rural Home Life, 137
  Rural Journalism, 121
  Rural Sociology, 135
  Vegetable Gardening, 89
  Veterinary Science, 111
  Zoölogy, 114
Division of Agriculture, 67
  Horticulture, 79
  Humanities, 117
  Rural Social Sciences, 129
  Science, 92
Experiment station, 11
Experiment station staff, 20
Extension service, 173
Extension service staff, 21
Faculty, members of the, 16
Faculty, standing committees of the, 26
General information, 183
Graduate assistants, 25
Graduate school, 145
Historical statement, 11
Infirmary, 192
Laboratory fees, 186
Library staff, 24
Major system, 44
Members of the corporation, 14
Military Science and Tactics, department of, 139
Officers of the institution, 16
Physical Education and Hygiene, Department of, 142
Prizes, 194
Registration, 1920–21, 202
Roll of students, 202
Rooms, 190
Short-course enrollment, 213
Short courses, 167
Student accounts, 191
  Activities, 193
  Aid, 190
  Enrollment, 202
  Expenses, 185
  Relations, 191
Student registration, 202
Trustees of the college, 14
Women students, 190

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ANNUAL REPORT

OF

THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

Parts I and II

1920

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MASSACHUSETTS AGRICULTURAL COLLEGE

THIRTY-THIRD ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

PARTS I AND II

1863

Publication of this Document
approved by the
Supervisor of Administration.

THIRTY-THIRD ANNUAL REPORT

OF THE

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

PART I

REPORT OF THE DIRECTOR AND OTHER OFFICERS

PART II

DETAILED REPORT OF THE EXPERIMENT STATION

BEING PARTS III AND IV OF THE FIFTY-EIGHTH ANNUAL REPORT
OF THE MASSACHUSETTS AGRICULTURAL COLLEGE

A RECORD OF THE THIRTY-EIGHTH YEAR FROM THE FOUNDING OF THE STATE AGRICULTURAL
EXPERIMENT STATION

CONTENTS.

PART I.

PAGE
Officers and staff, ... 1*a*
Report of the Director, ... 3*a*
Report of the treasurer, ... 10*a*
Reports of the departments: —
  Agricultural Economics, ... 12*a*
  Agriculture, ... 15*a*
  Botany, ... 19*a*
  Chemistry, ... 23*a*
  Cranberry Station, ... 32*a*
  Entomology, ... 36*a*
  Horticultural Manufactures, ... 44*a*
  Horticulture, ... 46*a*
  Market-Garden Field Station, ... 48*a*
  Meteorology, ... 50*a*
  Microbiology, ... 52*a*
  Poultry Husbandry, ... 54*a*
  Veterinary Science, ... 55*a*

PART II.

Bulletin No. 195, Tobacco Investigations: Progress Report, ... 1
Bulletin No. 196, Methods of Applying Manure, ... 39
Bulletin No. 197, The Nutritive Value of Cattle Feeds. 1. Velvet Bean Feed for Farm Stock, ... 61
Bulletin No. 198, Studies of Cranberries during Storage: Chemical Studies, 75
  Fungi Studies, ... 88
Bulletin No. 199, Broodiness in Domestic Fowl: Data Concerning its Inheritance in the Rhode Island Red Breed, ... 93
Bulletin No. 200, The Nutritive Value of Cattle Feeds. 2. Oat By-Products for Farm Stock, ... 117

Massachusetts Agricultural Experiment Station.

OFFICERS AND STAFF.

COMMITTEE.

Trustees.	Charles H. Preston, *Chairman*,	Hathorne.
	Edmund Mortimer,	Grafton.
	Arthur G. Pollard,	Lowell.
	Harold L. Frost,	Arlington.
	Arthur W. Gilbert,	West Brookfield.

The President of the College, *ex officio.*
The Director of the Station, *ex officio.*

STATION STAFF.

Administration.	Sidney B. Haskell, B.Sc., *Director.*[1]
	Fred W. Morse, M.Sc., *Acting Director.*[2]
	Joseph B. Lindsey, Ph.D., *Vice-Director.*
	Fred C. Kenney, *Treasurer.*
	Charles R. Green, B.Agr., *Librarian.*
	Mrs. Lucia G. Church, *Secretary to the Director.*
	Miss F. Ethel Felton, A.B., *Clerk and Editorial Assistant.*
Agricultural Economics.	Alexander E. Cance, Ph.D., *Professor.*
	Miss Lorian P. Jefferson, M.A., *Assistant Research Professor.*[3]
Agriculture.	William P. Brooks, Ph.D., *Consulting Agriculturist.*
	Edwin F. Gaskill, B.Sc., *Assistant Research Professor.*
	Robert L. Coffin, *Investigator.*
Botany.	A. Vincent Osmun, M.Sc., *Professor.*
	George H. Chapman, Ph.D., *Research Professor.*[4]
	Paul J. Anderson, Ph.D., *Professor.*
	Orton L. Clark, B.Sc., *Assistant Professor.*
	Webster S. Krout, M.A., *Assistant Research Professor.*
	Miss Marguerite G. Ickis, M.A., *Curator.*
	Alyn S. Ball, *Laboratory Assistant.*
	Miss Ellen L. Welch, A.B., *Clerk.*[5]
	Miss Gladys I. Miner, *Stenographer.*[6]
Cranberry Substation.	Henry J. Franklin, Ph.D., *Research Professor in Charge.*

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[1] Appointed July 1, 1920.

[2] Until July 1, 1920.

[3] Appointed June 1, 1920.

[4] Absent on leave, Jan. 1 to March 15, 1920.

[5] Resigned Nov. 5, 1920.

[6] Appointed Oct. 1, 1920.

Entomology.	Henry T. Fernald, Ph.D., *Professor.*
	Arthur I. Bourne, A.B., *Investigator.*
	Harlan N. Worthley, B.Sc., *Investigator.*[1]
	Miss Bridie E. O'Donnell, *Stenographer.*
Horticulture.	Frank A. Waugh, M.Sc., *Head, Division of Horticulture.*
	Fred C. Sears, M.Sc., *Professor of Pomology.*
	Jacob K. Shaw, Ph.D., *Research Professor of Pomology.*[2]
	Harold F. Tompson, B.Sc., *In Charge of Market-Garden Field Station.*
	Walter W. Chenoweth, M.Sc., *Professor of Horticultural Manufactures.*
	Miss Ethelyn Streeter, *Stenographer.*
Meteorology.	John E. Ostrander, A.M., C.E., *Meteorologist.*
Microbiology.	Charles E. Marshall, Ph.D., *Professor.*
	Arao Itano, Ph.D., *Assistant Professor.*
Plant and Animal Chemistry.	Joseph B. Lindsey, Ph.D., *Chemist.*
	Edward B. Holland, Ph.D., *Research Professor.*
	Fred W. Morse, M.Sc., *Research Professor.*
	Henri D. Haskins, B.Sc., *Official Chemist, Fertilizer Control.*
	Philip H. Smith, M.Sc., *Official Chemist, Feed Control.*
	Lewell S. Walker, B.Sc., *Assistant Official Chemist, Fertilizer Control.*
	Carleton P. Jones, M.Sc., *Assistant Research Professor.*
	Carlos L. Beals, M.Sc., *Assistant Research Professor.*
	Arthur M. Clarke, A.B., *Assistant Chemist.*[3]
	Miss Anne C. Messer, B.A., *Investigator.*
	Miss Ethel M. Bradley, B.A., *Analyst.*
	Raymond W. Swift, B.Sc., *Analyst.*[4]
	James T. Howard, *Inspector.*
	Harry L. Allen, *Laboratory Assistant.*
	James R. Alcock, *Assistant in Animal Nutrition.*
	Miss Rebecca L. Mellor, *Stenographer.*
	Miss Cora B. Grover, *Stenographer, Control Service.*
Poultry Husbandry.	John C. Graham, B.Sc., *Professor.*[5]
	Loyal F. Payne, B.Sc., *Acting Head of Department.*[6]
	Hubert D. Goodale, Ph.D., *Research Professor.*
	Miss Ruby Sanborn, *Clerk.*
	Miss Doris Tower, *Stenographer.*
Veterinary Science.	James B. Paige, B.Sc., D.V.S., *Professor.*
	G. Edward Gage, Ph.D., *Professor of Animal Pathology.*
	Thomas G. Hull, Ph.D., *Assistant.*[7]
	John B. Lentz, V.M.D., *Assistant Research Professor.*[8]

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[1] Appointed July 1, 1920.

[2] Reappointed June 1, 1920.

[3] Resigned Sept. 30, 1920.

[4] Appointed Oct. 1, 1920.

[5] Reinstated April 1, 1920, after leave of absence.

[6] Until April 1, 1920.

[7] Temporary appointment, resigned Jan. 10, 1920.

[8] Temporary appointment, Feb. 4 to May 31, 1920; permanent appointment, June 1, 1920.

REPORT OF THE DIRECTOR.

SIDNEY B. HASKELL.

The work of the Experiment Station this past year has been affected by many of the personal factors which so influenced work in other major subdivisions of the institution. Chief among these factors has been that of uncertainty as to the future, brought about by delay in securing the salary adjustment necessary to make the rate of pay somewhat more nearly comparable to the increased cost of living. This delay produced a feeling of uneasiness absolutely inimical to the good conduct of research work. Despite this fact, there have been but few changes in staff membership, these being as follows: —

Arthur M. Clarke resigned the position of assistant chemist on Sept. 30, 1920, and was succeeded by Mr. Raymond W. Swift, a graduate of the College with the class of 1920.

Dr. Thomas G. Hull, assistant in the Department of Veterinary Science, resigned Jan. 10, 1920. Dr. John B. Lentz, who resigned Sept. 18, 1919, having been in the service of the institution about three years, was reappointed February 4, as assistant research professor in the Department of Veterinary Science.

Prof. Fred W. Morse, who had been serving as acting director since the retirement of Dr. William P. Brooks, in March, 1918, resumed his work as research professor of chemistry on July 1.

Dr. Jacob G. Shaw was reappointed to the position of research professor of pomology, beginning June 1, 1920. Dr. Shaw comes back to this institution from service as head of the Department of Horticulture in the University of West Virginia.

Miss Lorian P. Jefferson, formerly assistant professor in the Division of Rural Social Science in the College, was appointed assistant research professor in agricultural economics, effective June 1.

Miss Ellen L. Welch, clerk in the Department of Botany, resigned Nov. 5, 1920, her position being taken by Miss Gladys I. Miner.

CHANGES IN DEPARTMENTAL ORGANIZATION.

With the development of larger bodies of knowledge in technical agricultural subjects has come increasing specialization. This has rendered necessary certain changes in organization in order that the work of the Experiment Station might conform to the departmental organization of the College. During the year just past the trustees approved the following changes, to become effective Dec. 1, 1920: —

Department of Horticulture, first recognized as an Experiment Station department in 1888, when the Hatch Experiment Station was organized, to be discontinued.

In place of the Department of Horticulture the following departments to be organized: —

Department of Pomology, with Prof. Fred C. Sears, head.

Department of Horticultural Manufactures, under the leadership of Prof. Walter W. Chenoweth.

Department of Market Gardening, and Market-Garden Field Station, under the leadership of Prof. H. F. Tompson.

The above changes in organization indicate no change in scope of work.

PUBLICATIONS OF THE YEAR.

The sole avenue through which the Experiment Station work can be taken at once to the people of the State lies in the publication of pamphlets and bulletins. Below is presented a list showing the publications of the year. Unfortunately, appropriations for publications were so small as to make it impossible to complete publication of all manuscripts which have been submitted. It is hoped that a larger sum will be available for the coming year.

PUBLICATIONS ISSUED DURING 1920.

Annual Report.

Thirty-second annual report: —

Part I. Report of Director and Other Officers; 48 pages.

Part II. Detailed Report of the Experiment Station; 258 pages (being Bulletins Nos. 189–194).

Combined Contents and Index, Parts I and II; 20 pages.

Bulletins.

No. 195. Tobacco Investigations: Progress Report, by G. H. Chapman; 38 pages.
No. 196. Methods of Applying Manure, by Wm. P. Brooks; 22 pages.
No. 197. Nutritive Value of Cattle Feeds. 1. Velvet Bean Feed for Farm Stock, by J. B. Lindsey and C. L. Beals; 14 pages.
No. 198. Studies of Cranberries during Storage; 18 pages.
  Chemical Studies, by F. W. Morse and C. P. Jones.
  Fungi Studies, by B. A. Rudolph and H. J. Franklin.
No. 199. Broodiness in Domestic Fowl: Data concerning its Inheritance in the Rhode Island Red Breed, by H. D. Goodale, Ruby Sanborn and Donald White; 24 pages.
No. 200. Nutritive Value of Cattle Feeds. 2. Oat By-Products for Farm Stock, by J. B. Lindsey and C. L. Beals; 20 pages.

Bulletins, Popular Edition.

No. 200. Nutritive Value of Cattle Feeds. 2. Oat By-Products for Farm Stock, by J. B. Lindsey and C. L. Beals; 10 pages.

Bulletins, Control Series.

No. 13. Inspection of Commercial Feedstuffs, by Philip H. Smith and Ethel M. Bradley; 27 pages.
No. 14. Inspection of Commercial Fertilizers, by H. D. Haskins, L. W. Walker and A. M. Clarke; 92 pages.

Meteorological Reports.

Nos. 373–384, inclusive, 4 pages each.

THE PROJECT SYSTEM.

An important development of the year is the attempt to organize all Experiment Station work on a definite project basis. This change is peculiarly necessary at the present time, owing to the fact that agricultural research has to a great degree passed beyond the simple "test" phase of its work. The problems which must now be undertaken are those which require in a great degree co-ordination between departments. Especially is this true of the work of the technical departments, for without exception these departments must make use of the fundamental sciences as tools in their investigation. It is neither practicable nor desirable, however, for each of these technical departments to duplicate the scientific equipment of the fundamental scientific departments. Seemingly the only way in which effective co-operation can be brought about lies in securing the necessary co-ordinated study.

This work of project organization is not yet completed. The following, however, shows the projects either now under way, or so organized as to be under way in the very near future: —

Plant Nutrition — Comparative Fertilizer and Lime Tests.

Comparison of nitrogenous fertilizers; comparison of sulfate and muriate of potash; comparison of potash carriers; comparison of phosphate carriers; effects of plant foods alone and in combination; use of chemicals in supplementing stable manure for garden crops; orchard fertilization; experiments with Barium-Phosphate; relative value of different sources of lime; high potash *versus* high phosphoric acid fertilizers; study of bacterized peat; manure economy tests.

Plant Nutrition — Chemical and Biological Investigations.

Chemical effects of muriate and sulfate of potash; lime absorption and acidity of Field A; soil fertility as influenced by micro-organisms.

Plant Adaptation — Variety Tests.

Variety tests of fruits; asparagus variety test; limited variety test of vegetables; observations of summer forage crops.

Plant Physiology and Heredity.

Study of optimum conditions of light for plant response; the interrelation of stock and scion in apples; the genetic composition of peaches; study of tree characters of fruit varieties; study of the life processes of the strawberry.

Cultural Studies.

Cranberry bog management; cranberry bog weeds; blueberry culture; experiments in pruning apples; study of production with greenhouse lettuce and cucumbers.

Plant Protection — Insects.

Studies of insect outbreaks in various localities; limits of insect pests in Massachusetts; the number of broods of the codling moth in a year; dates of hatching of scale insects, and fixing dates for spraying such insects; insects affecting the cranberry; control of the onion maggot; control of the squash-vine borer; burning of foliage by insecticides; control of the squash bug; insect control on market-garden crops; study of the chemistry of arsenical insecticides.

Plant Protection — Fungous Troubles.

Investigation of onion diseases; experimental spraying for control of cucumber mildew under glass; methods for controlling lettuce drop; fungous diseases of cranberries (co-operative with the Bureau of Plant Industry, United States Department of Agriculture).

Plant Studies — Miscellaneous.

Study of tobacco sickness and tobacco-sick soils; studies of cranberry storage and shipping conditions.

Animal Nutrition.

Comparative feeding tests and feeding trials of new materials; record of the Station herd; digestion experiments with sheep; a study of rations for horses.

Animal Physiology.

A study of the chemistry of butter fat, etc.; determination of the mode of inheritance of various characters in poultry.

Animal Pathology.

Methods of diagnosis of bacillary white diarrhea; elimination of disease in poultry; study and control of poultry diseases in College and Station flocks; study and control of bovine abortion; study of hog cholera and the use of serum.

Meteorological Studies.

Weather observations, with especial attention to frost protection; areas in which immunity from early and late frosts may be expected, and the consequent effect on selection of crops; general weather observations.

Studies in Food Distribution.

Methods and costs of distribution of tobacco and onions; study of consumers' co-operative associations (in co-operation with the Bureau of Markets, United States Department of Agriculture).

Studies in Food Preservation.

Canning investigations.

Progress in some of these investigations is handicapped by a shortage of land. This condition is due primarily to the encroachment of buildings on the old Experiment Station grounds, but in addition is due to the fact that land once used for certain types of experiment is rendered useless for other kinds of experiments for long periods of years. Therefore, while it is true that several of the present field experiments had best be brought to a close, yet the land involved will not become immediately available for other investigations. It is therefore hoped that the projects now in the hands of the trustees for the purchase of the Brooks Farm and of the Tuxbury land will receive the support of the Legislature.

In this connection it should be stated that the time is coming when the Experiment Station must branch out and undertake thoroughgoing work in other sections of the State. A start in this direction was made about ten years ago when the Cranberry Station was first organized. The success of this station has been so marked as to gain the unqualified support of cranberry growers. The Market-Garden Field Station was later established at North Lexington, although in the beginning not on an experimental basis. The next step, logically, is to go west of the Connecticut and establish an experimental substation in the hills of western Hampshire, Franklin or Hampden county. Many technical problems of production must be solved before these hill farms can be brought back to their old-time productive condition.

ADDITIONAL ASSISTANTS.

An unexpected result of the organization and development of the county farm bureaus has been the increased demand made on the Experiment Station for service in investigating problems affecting agriculture. The inability of the Station to meet these demands is causing criticism. While there is no doubt that much of this criticism arises from ignorance rather than knowledge, yet the fact is that the farmers of the State, as represented by their county agricultural agents, are more eager than ever for knowledge and for facts. The Experiment Station cannot ignore these demands, and is making every effort in its power to meet them. At present, however, investigations under way are so numerous and so important as to make it almost imperative that we secure additional assistants to give attention to the new problems which are constantly arising. Those needed in the immediate future are as follows: —

Assistant to the Director.
Clerk and graduate assistant, Department of Agricultural Economics.
Assistant research professor, Department of Botany.
Assistant research professor, Department of Horticultural Manufactures.
Assistant in experimental market gardening, Market-Garden Field Station.
Assistant in experimental pomology and graduate assistant, Department of Pomology.
Assistant research professor and two graduate assistants, Department of Microbiology.
Poultry pathologist,[1] Department of Veterinary Science.
Research professor and laboratory assistant, Department of Farm Management.
Research professor, Department of Rural Sociology.
Poultry pathologist[1] and collector of blood samples, Poultry Disease Law.

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[1] One-half time.

Acknowledgment.

In conclusion I wish to acknowledge the hearty and loyal co-operation accorded me by the different members of the Experiment Station staff. I believe that the time which is usually lost through change in any administrative organization will be somewhat decreased through the services thus freely given. Particularly I wish to express my appreciation of the co-operation given me by Dr. William P. Brooks, formerly director of the Station and now consulting agriculturist; Prof. F. W. Morse, formerly acting director; and Dr. J. B. Lindsey, vice-director of the Station. All of these men have spared no pains in placing at my disposal all information needed in prosecuting the work.

REPORT OF THE TREASURER.

ANNUAL REPORT

Of Fred C. Kenney, Treasurer of the Massachusetts Agricultural Experiment Station of the Massachusetts Agricultural College, for the Year ending June 30, 1920.

United States Appropriations, 1919–20.

		Hatch Fund.	Adams Fund.
Dr.			
To receipts from the Treasurer of the United States, as per appropriations for fiscal year ended June 30, 1921, under acts of Congress approved March 2, 1887, and March 16, 1906,		$15,000 00	$15,000 00
Cr.			
Adams: —			
By salaries,	$14,448 31		
labor,	272 00		
chemicals and laboratory supplies,	4 58		
seeds, plants and sundry supplies,	58 89		
fertilizers,	216 22		
	$15,000 00		15,000 00
Hatch: —			
By salaries,	$14,081 50		
labor,	918 50		
	$15,000 00	15,000 00	

State Appropriations.

Cash balance brought forward from last fiscal year,	$21,992 62
Cash received from State Treasurer,	55,875 80
fees,	155 77
sales,	5,530 79
miscellaneous,	2,022 02
	$85,577 00

Cash paid for salaries,	$26,206 90
labor,	14,591 80
publications,	3,182 72
postage and stationery,	1,387 81
freight and express,	303 45
heat, light, water and power,	353 52
chemicals and laboratory supplies,	945 99
seeds, plants and sundry supplies,	1,659 57
fertilizer,	763 08
feeding stuffs,	1,007 98
library,	873 08
tools, machinery and appliances,	942 87
furniture and fixtures,	190 55
scientific apparatus and specimens,	198 12
live stock,	15 00
traveling expenses,	2,091 49
contingent expenses,	37 65
buildings and land,	1,124 22
Remitted to State Treasurer,	29,701 20
Total,	$85,577 00

REPORT OF THE DEPARTMENT OF AGRICULTURAL ECONOMICS.

ALEXANDER E. CANCE.

The research work of the department has been carried on along three lines: —

Consumers' Co-operation in Massachusetts. — For about two months the department co-operated with the Federal Bureau of Markets in a brief study of consumers' co-operation in Massachusetts. Since the period given to this work was short, it was impossible to do more than study types of co-operative enterprises among consumers, no effort being made to arrive at the total membership in such organizations or their total volume of business.

The forms of so-called co-operative consumers' organizations found in the State were: —

(*a*) Buying clubs, — unincorporated groups which buy supplies together but keep no stock of goods on hand and distribute orders by the easiest method possible.

(*b*) Stores, organized, owned and operated by the consumers, each member owning so much stock in the business and having a vote in all business matters. These are incorporated groups, some few of which have been doing business for a number of years.

(*c*) So-called co-operative stores: in reality stores maintained for the employees of a manufacturing company by the company itself. At these stores goods are offered at less than the price asked at neighboring retail stores, the company carrying all the overhead expenses of rent, heat, light and clerk hire. One firm frankly acknowledged that they expected to lose $10,000 a year on the enterprise. On the other hand, another store was found which was started by the firm for its employees, but which has gradually passed into the hands of the employees, the firm now having nothing to do with the conduct of the store, and supplying nothing but the quarters which it occupies.

This brief study revealed an increasing interest in co-operation among consumers. Stores are being opened by all classes, but chiefly among factory employees. Labor leaders are interested in the movement, which is especially strong among foreigners, particularly the Italians and Finns, the latter having sixteen stores of various kinds in the State.

A number of requests were received for assistance in securing farm products for these consumers' associations. These were turned over to the Extension professor of the department, who has taken steps to render the assistance asked.

Farm Ownership in Massachusetts. — The second line of research which has been carried on throughout the year is a study of farm ownership in Massachusetts. A questionnaire was prepared and has been filled out by 650 farmers of the State, some of the schedules being secured by mail and some by personal visits. The county agents of several counties have rendered most valuable assistance in this matter. Although the study is yet incomplete, some interesting facts with regard to the steps to farm ownership are already in hand. It is expected that a bulletin embodying the results of this study will be ready for publication within the year.

Onion Supply and Distribution in the Connecticut Valley. — The department is bringing up to date the data on onion supply and distribution in the Connecticut valley previously published in Bulletin No. 169. The supply, weekly shipments, destinations, prices, storage stocks and recent developments in preparation and marketing are the principal data studies. It is the purpose of the department to publish during 1921 a supplement to Bulletin No. 169 embodying these new data.

Proposed Research Work for the Coming Year.

Supply and Distribution of Connecticut Valley Tobacco. — It is proposed to gather similar information with reference to the supply and distribution of cigar leaf tobacco in the Connecticut valley to supplement Bulletin No. 193 published in 1919.

This bulletin, entitled "The Supply and Distribution of Connecticut Valley Cigar-leaf Tobacco," was prepared by Samuel H. DeVault, at that time assistant in the department. The bulletin has been of such service to both growers and dealers that it is deemed advisable to bring up to date the information therein presented.

Local Balance of Trade. — The line of investigation on which the emphasis will be laid, with the approval of the trustees, is a study of the local balance of trade in certain markets. Specifically it is suggested that this study be made in Fitchburg, Lynn and Lawrence, with perhaps some others to be added later. The products to be considered will be those which cannot be grown locally; products which might profitably be grown but for some reason are not (for this portion of the study the assistance of various members of the Division of Agriculture will be enlisted); products which are grown locally but not in sufficient quantity to supply the local market; products grown locally in quantity sufficient to supply the local market with a surplus for export; products which are exported with shipments returned to the local market or duplicated by shipments from outside areas.

Clerical assistance is much needed in order to expedite the work. At present the only clerical help available is that assigned to the instructional staff. The work demands a competent clerk capable of doing stenographic work and tabulations, and of looking up statistical data.

REPORT OF THE DEPARTMENT OF AGRICULTURE.

E. F. GASKILL.

The work of the Agricultural Department during the past year has progressed along the same general lines as heretofore. A large part of the work has had to do with a study of different phases of the problem of soil fertility, which has necessitated the care and management of a large number of field plots. Many of these plots have received a continuous treatment since the organization of the Experiment Station in 1888, while some, owing to the disappearance of certain fertilizer materials from the market during the war and the scarcity of others, have undergone material changes and rearrangements. Despite these changes there are several significant facts brought out by the crop yields of the season just past.

Field A, or the Nitrogen Field. — Three plots on Field A (the nitrogen field) gave an average crop of hay and rowen of slightly more than 3,100 pounds per acre. This yield, while not large, was significant in that these plots had received no nitrogen in either fertilizer or manure for a period of thirty years. The records on this series of plots are becoming increasingly valuable year by year, indicating a distinct gain of nitrogen through the growth of leguminous crops. Another record from this field of more than incidental value is the fact that although a mixture of grasses and clovers was sown last year, this year's crop was practically free of clovers except on the no-nitrogen plots. Once again the fact that large amounts of commercial nitrogen are somewhat antagonistic to the growth of clovers is strikingly demonstrated.

The Response of Crops to Potash. — The response of crops to potash when used on different types of soil is brought out by a comparison of the yields on two of the Experiment Station fields. The soil on the South Soil Test is considered a light loam, while that on Field G is a heavy, silt loam. In both fields there are plots to which no potash has been applied for years, but which have received annual applications of nitrogen and phosphoric acid. The rates of application of these plant-food elements per acre are shown in the following table: —

FIELD.	Total Nitrogen (Pounds).	Total Phosphoric Acid (Pounds).	Total Potash (Pounds).
South Soil Test,	About 25 (as nitrate),	51 (from acid phosphate),	80
Field G,	39 (from nitrate), 20 (from tankage),	57½ (from acid phosphate), 30 (from tankage),	135

The increase due to the use of potash on these fields for different crops over a long term of years is shown in the following table: —

CROP.	SOUTH SOIL TEST.		FIELD G.	
	Number of Years grown.	Increase per Acre due to Potash.	Number of Years grown.	Increase per Acre due to Potash.
Corn,	9	32½ bushels,	3	½ bushel.
Soy beans,	1	12.8 bushels,	4	¼ bushel.
Mixed hay,	6	738½ pounds,	3	1,735½ pounds.[1]
Rowen,	4	405 pounds,	–	–
Clover,	–	–	2	598 pounds.
Potatoes,	–	–	5	54.1 bushels.

[1] Includes hay and rowen.

These two fields are scarcely more than 200 yards apart. The soil survey map published by the Bureau of Soils, United States Department of Agriculture, classifies them together. Were the land still used as a farm instead of for experimental purposes, the two areas would probably be thrown together in the same field, and put to the same uses. Yet we have one part where without potash corn cannot grow; another part where the use of liberal quantities of fertilizer potash makes scarcely a perceptible difference in the yield of corn. So varied are our New England soils!

The Effect of Nitrogen, Phosphoric Acid and Potash on Corn and Grass. — An opportunity was offered during the past two seasons to study the same crop on three of our experimental fields, — namely, the nitrogen field, the potash field and the phosphate field. During 1919 these three fields were in corn. In one case the limiting factor was nitrogen, in another potash and in another phosphoric acid. On all of these fields there were certain plots that have received incomplete mixtures; for example, the check plots on the potash field received no potash. The rates of application of the several plant-food elements per acre are shown in the following table: —

FIELD.	Total Nitrogen (Pounds).	Total Phosphoric Acid (Pounds).	Total Potash (Pounds).
Nitrogen Field,	45,	80 (from acid phosphate),	125
Potash Field,	39 (from nitrate), 20 (from tankage),	57½ (from acid phosphate), 30 (from tankage),	135
Phosphate Field,	56 (from nitrate), 20 (from ammonia), 14.6 (from organic nitrogen),	96,	150

The yields of hard corn follow, the figures representing bushels per acre: —

FIELD.	Incomplete Fertilizer or Check.	Complete Fertilizer.	Gain of Complete over Incomplete.
Nitrogen Field,	48.7 (P+K)	66.3	17.6
Potash Field,	49.6 (N+P)	64.3	14.7
Phosphate Field,	57.6 (N+K)	65.0	7.4

The significance of these figures lies in their uniformity. The average product of complete fertilizer treatment on all three fields is practically the same.

During the past season these same fields were in grass and clover, the seed mixture sown being the same in all cases. The hay yields on these fields were as follows, the figures representing pounds per acre: —

Field.	Incomplete Fertilizer or Check.	Complete Fertilizer.	Gain of Complete over Incomplete.
Nitrogen Field, ...	3,148.3	5,163.4	2,015.1
Potash Field, ...	5,944.0	6,210.3	266.3
Phosphate Field, ...	7,060.0	7,902.4	842.4

Comparison of the grass yields of this year with the corn yields of last year is illuminating. Last year the complete fertilizer treatment, varied as it was on the different soils, gave uniform yields of corn. This year the same treatment gave rather diverse yields of hay. All of this happened, however, within a section of land which might well be compassed by the boundaries of a 5-acre lot. Very evidently the peculiar soil conditions in New England make very difficult the drawing of generalizations from fertility field experiments.

REPORT OF THE DEPARTMENT OF BOTANY.

A. VINCENT OSMUN.

The work of the Department of Botany during the last year has not deviated in any important respect from that previously reported. Research work, the normal function of the Experiment Station, continued to engage the major attention of the staff. While no new projects were started, certain changes and additions were made in some of those under way.

Report on Project Work.

The report on project work is one of progress. Some lines of investigation are essentially completed. Several bulletins and technical papers are in course of preparation by members of the staff, and will be presented for publication as speedily as other work will permit.

Tobacco Investigations. — Tobacco investigations, under the leadership of Dr. G. H. Chapman, have so developed that it has become advisable to discontinue the plots located on privately owned farms during the last four years. The project has been reorganized, and in the future plots will be conducted on College-owned land controlled by the Station. A progress report on the project was published in March of the present year as Bulletin No. 195.

Investigation of Onion Diseases. — Investigation of onion smut under the project on onion diseases has continued, with results on the field plots confirmatory of those previously obtained. A large amount of painstaking work on the morphology and life history of the onion smut fungus, *Urocystis cepulæ,* has been carried on by Dr. P. J. Anderson, who expects to publish a technical paper on these phases of the investigation during the next year.

Optimum Conditions of Light for Plant Response. — Prof. O. L. Clark has continued to accumulate experimental data in his study of optimum light requirements of plants. That phase of the work embracing study of the influence of different light intensities on plants grown under cloth of different meshes has been discontinued after several years of field tests. A new feature of this work now being planned will deal with the influence of ultra-violet light on plants.

Plant Diseases of the Year.

While the plant diseases coming under our observation were as numerous and varied as in almost any other year, few new or unusual troubles were among them.

Tobacco. — A bacterial disease of tobacco, known in the South as wildfire, was reported for the first time in this State, though there is evidence to support the belief that it was present at least two years earlier. During the curing and fermentation season for tobacco, the weather conditions favored development of such troubles as pole-sweat, stem-rot, canker and moldy or musty tobacco. Considerable loss ensued, and there were many calls for assistance. An Extension bulletin, entitled "Curing and Fermentation Troubles of Tobacco," and an Extension circular on "Tobacco Wildfire," were prepared by Dr. Chapman.

Tomato. — Late in September, Septoria leaf-spot of tomato, caused by *Septoria lycopersici* Speg., was discovered in a small garden in Amherst where it had caused severe defoliation of the vines. The disease previously has been noted on two occasions in greenhouses of the State, but this is the first report of its occurrence out of doors in Massachusetts. In the Middle Atlantic States this disease causes large losses, and is rated as the most serious disease of the tomato in that region. Should it gain a foothold in this State it might become a problem of considerable economic importance.

Carrot. — What appears to be a new disease of the carrot was first called to our attention in 1918 at the Market-Garden Field Station by Prof. H. F. Tompson. The disease seems to be very destructive at times, and while it received some attention in 1919 and 1920, it is deserving of careful investigation, and will be made the subject of a project. Its cause has not been determined, but it appears to be of fungous origin.

Eggplant. — In 1919 a disease of eggplant, evidenced by wilting and death of the entire plant, was reported from the market-garden sections of the State. One large grower lost a large part of his crop. Preliminary investigation failed to establish definitely the cause of the trouble, and in the absence of this information the grower was advised to plant in 1920 on new land not previously used for this crop. This was done, with the result that the disease in question appeared in only one row, and it developed that this row — the only one of the 1920 planting — was located on a section of the land where the disease occurred in 1919. During the summer Mr. Krout definitely determined the cause of the disease to be a fungus of the genus Verticillium. This disease has been previously reported in other parts of the country, but has had little attention from investigators.

Potato. — Late-blight of potato, always a possible menace to the crop, took a heavy toll the last season. The disease was first observed August 9. Abnormally high humidity throughout August and September, with heavy rainfall in the latter month, furnished conditions highly favorable to the development of the causal fungus. As usual, fields carefully and systematically sprayed with homemade Bordeaux mixture suffered the least. Up to the time of this writing many reports of storage rot due to late-blight have come to the department, and it is probable that the loss from this source will be large.

Apples. — A heavy crop of apples in a season of weather conditions which favored the development of scab and black-rot meant a large initial loss from these diseases in the orchard. The heaviest outbreaks occurred in the eastern part of the State, where early varieties, such as Gravenstein and Yellow Transparent, suffered from black-rot, and McIntosh from scab. In one small area growers estimate that these diseases reduced the value of their crop fully $200,000. The best control measures known have been employed in eastern Massachusetts, and their partial failure indicates that some factor or factors have been overlooked. This points to just one thing, — the need of investigation to determine how these diseases may be controlled. Because it is apparent that there are unknown factors in the problem, investigational work must start with a careful and detailed study of causal organisms and the relation of environmental conditions to their development. Without this fundamental knowledge the problem of control cannot be attacked with any degree of intelligence. The need of instituting work along this line was pointed out in our last annual report. The experience of the past year has made the need even more urgent. The department is ready to undertake the work whenever financial provisions can be made. This, however, is but one of many lines of investigational work pressing for attention by the Department of Botany. Some of these were referred to in our last report.

Seed Work.

There has been the usual amount of seed work, including germination tests of a variety of vegetable, cereal and grass seeds, and many samples of tobacco and onion seeds; examination of grass seeds to determine purity and the presence of weed seeds; and cleaning and separation of tobacco, onion, lettuce, parsnip and celery seeds.

Extension Work.

Plant disease diagnosis, with the prescribing of remedial measures, demanded more time and attention than in any previous year. The constantly increasing burden of this work tends more and more to interfere with the efficient prosecution of research, and emphasizes the need of an Extension specialist in plant diseases, which has been frequently urged. It is most desirable that this need be met in the near future by the appointment of an Extension plant pathologist to be a member of the staff of the department. The necessity of keeping this type of work within the Department of Botany cannot be pressed too strongly, as it is essential that the department, through the close co-operation of all members of its staff, be constantly and intimately in touch with all the plant disease problems of the State.

REPORT OF THE DEPARTMENT OF CHEMISTRY.

J. B. LINDSEY.

Research Section.

Butter Fat Studies. — Experiments to note the effect of coconut, corn, peanut and soy bean oils upon the chemical character of butter fat have been made during the past year, but owing to the interference of other work the laboratory studies have not been completed. Methods, either direct or indirect, have already been devised for determining with a reasonable degree of accuracy the percentages of the several soluble and insoluble fatty acids of butter fat, and the work of studying food influence is being prosecuted as fast as time will permit.

Insecticides and Fungicides. — A considerable amount of work has been done upon insecticides and fungicides in co-operation with the Department of Entomology, and a number of proprietary products have been examined.

Several poison cases have been investigated for other departments of the College. While this latter is not research work, it was quite necessary and required the services of a specialist.

A method of analysis of lime-sulfur mixtures has been developed which will be submitted for publication in some chemical journal. The method is adapted to the analysis of any of the water-soluble sulfides.

Animal Nutrition. — A thorough study has been made of the nutritive value of oat by-products, — hulls, middlings, and the mixture of the two, known as mill run oat feed, — and the results are now in press.

Digestion studies with sheep have been completed with the several oat by-products, and also with peanut skins, shells and meal, coffee refuse, coconut meal and cottonseed meal.

Metabolizable energy trials of wheat bran, cottonseed and linseed meals, corn cobs and different varieties of hay have been made with horses. The results in some cases have proved so contradictory that repetitions are now in progress.

Experiments with twelve pigs have just been completed, to note the nutritive and economic value of feeding different amounts of semi-solid and evaporated buttermilk. Because of the high prices of grain as compared with the market price of the pork produced the experiment was not a financial success. The least loss, however, was sustained on the pigs receiving grain alone, followed in succession by those receiving rations composed of grain plus tankage, grain plus powdered buttermilk, and grain plus semi-solid buttermilk.

A demonstrative trial was undertaken with two groups of six pigs each, to observe the value of pasturage and partial soiling as supplements to grain feeding. Because of imperfect control the results were not as satisfactory as desired, but they tend to confirm similar observations elsewhere, which have demonstrated that this method of pork production is well worthy of serious trial by farmers in Massachusetts. It is doubtful, however, in view of the high cost of labor, if much time can be spent in growing forage crops. An alfalfa or clover pasture, or even a fertile grass pasture, could be used, supplemented by grain from self-feeders.

Forage Crops. — Observations in planting soy beans with corn in different ways — mixed together in the drill in the proportion of two-thirds corn and one-third beans, together in the hill, and between the corn hills — were undertaken, but owing to the unsatisfactory character of the bean seed the results were in no way conclusive.

Sudan grass did not prove successful, for in spite of a reasonable amount of seed per acre — 24 pounds broadcast — a very light stand was secured. This condition has repeated itself with us for several years. The seed was sown upon a light, well-drained loam, June 15. Barnyard millet and early amber sorghum have proved more desirable forage crops.

Alfalfa, red clover and sweet clover have each been seeded together with peas and oats for two successive years. After the peas and oats were cut and removed, these legumes have come on well, and have produced a very satisfactory stand. The rains during the past two years were frequent, which favored their growth. If the season had been dry during the development of the peas and oats, it is doubtful if the legumes would have succeeded by this method of sowing. The clover grew so fast as to enable us to make a cutting in early September.

Respiration of Cranberries. — The study of cranberry respiration was concluded in the early part of the year. The results of the investigation and previous studies of chemical changes during storage have been prepared for publication in a bulletin which is now in press.

Soil Studies. — A striking recurrence on the plots of Field A in 1919, and again this spring, of the toxic effect on plant growth of sulfate of ammonia led to a repetition of some of the research work on the soils of plots 5 and 6, with reference to the presence of soluble salts of manganese, iron and aluminum. Large volumes of water extracts of the soils were prepared and concentrated by evaporation. The residues were analyzed, and amounts of manganese, iron and aluminum were determined by weight. There was found to be present at least 175 parts sulfate of manganese in 1,000,000 parts of dry soil, equivalent to 350 pounds in the upper 8 inches of an acre. This is sufficient to be very poisonous to many kinds of plants. Aluminum was present in much less quantity in the extract, and iron in little more than traces. These results confirm the conclusions of Ruprecht and Morse in previous bulletins of the Experiment Station. A study of the history of the field for thirty-two years has shown that injury on the plots receiving sulfate of ammonia has been most marked in seasons when droughts have occurred in the early summer. The addition of lime to the soil prevents the injury by promoting the formation of sulfate of lime instead of the other salts. Examination of limed soils from these plots showed much smaller quantities of manganese and aluminum in a soluble form, and larger quantities of lime.

FERTILIZER SECTION.

Fertilizer Inspection. — During the season of 1920, 98 manufacturers, importers and dealers have secured certificates for the sale of 583 brands of fertilizer, fertilizing materials and agricultural limes. In the year's inspection, 7,403 tons of fertilizer were sampled, necessitating the sampling of 17,919 sacks; 193 towns were visited; 1,311 samples, representing 492 distinct brands, were drawn from stock found in the possession of 716 different agents or owners; and 738 analyses were made. The table shows the number of brands of the different materials which were registered and sampled, as well as the number of analyses made: —

MATERIAL.	Brands registered.	Brands collected.	Number of Analyses.
Complete fertilizers,	292	250	331
Ammoniated superphosphates,	119	95	117
Superphosphate and potash,	6	3	3
Ground bone, tankage and dry ground fish,	54	51	78
Nitrogen compounds,	40	34	100
Phosphoric acid and potash compounds,	45	31	49
Wood ashes,	2	4	36
Lime compounds,	25	24	24
Totals,	583	492	738

A declaration of the tonnage of commercial fertilizers sold in Massachusetts between the dates of Jan. 1, 1920, and July 1, 1920, showed a total of 57,845 tons, divided as follows: —

	Tons
Mixed fertilizers,	47,842
Unmixed fertilizers,	10,003

Full details of the fertilizer inspection work may be found in Bulletin No. 14, Control Series, published in December, 1920.

Miscellaneous Analytical Work. — During the last two months in 1919 and the first three months in 1920 the usual amount of co-operative chemical work was done on problems of the Agricultural Department of the Experiment Station, and on vegetation experiments conducted by the fertilizer control section.

The fertilizer section has also analyzed 281 different substances sent in by farmers and by the various departments of the Experiment Station. In case of the large number of soil samples which have been examined, the tests made have been largely confined to a determination of the lime absorption capacity of the soils and their content of organic matter. It might be said with reference to the testing of the great variety of fertilizer by-products that an effort has been made, as in the past, to give reliable information in each case as to the best method of utilizing said by-products.

Vegetation Tests. — The following experiments were planned in the fertilizer section, but the details of growing the crops have been left, in all cases, to the Agricultural Department.

A pot experiment comprising 60 pots, with millet as a crop, was conducted to study the availability of the water insoluble organic nitrogen in certain commercial fertilizers found in the 1916 fertilizer inspection work. Many of these samples were considered of suspicious quality so far as their organic nitrogen source was concerned. The purpose of the experiment was to make further studies of the results of laboratory methods as compared with those obtained in vegetation tests. This work was planned several years ago, but due to a scarcity of coal it has not been possible to operate the greenhouse during the winter months, and this season presented the first opportunity for making the test.

An experiment comprising 12 pots, with oats as the crop, was conducted to show the residual effect of peat mixtures with and without commercial bacteria. This was a continuation of a pot experiment begun in 1919.

Another experiment was carried out, using 23 pots with tomatoes as the crop, to compare the effect of bacterized peat with peat which contained no commercial bacteria. This was to parallel work conducted in the field with tomatoes and potatoes during the seasons of 1919 and 1920.

The tile experiment with apatite and barium sulfide, begun in 1919, was continued this season, with oats followed by buckwheat as the crop. This experiment comprises 46 tile.

A field experiment with bacterized peat, comprising two fields of eight plots each, was continued from the previous year. The purpose of this experiment was the comparison of a mixture of bacterized peat with one containing no commercial bacteria. The crops (tomatoes and potatoes) were rotated, the field which was used for potatoes in 1919 being used for tomatoes this season, and *vice versa.*

Feed and Dairy Section.

The Feeding Stuffs Law (*Acts and Resolves for 1912, Chapter 527*). — During the year 1,002 samples of feeding stuffs were collected and analyzed. The results of the year's work, together with a discussion of some feeding problems, have been published as Bulletin No. 13 of the Control Series. The official inspector visited 204 dealers located in 113 towns. One thousand four hundred and sixty brands of feeding stuffs were registered for sale in Massachusetts by 305 manufacturers.

On account of the greatly increased cost of carrying out the provisions of the feeding stuffs act with no increase in appropriation, local prosecutions have not been attempted, the Experiment Station continuing to depend upon the co-operation of the Federal authorities for action against violators of the law when the feeds entered into interstate commerce. On the whole, the market, while not entirely free from low-grade material, has been quite free from misrepresentation and fraud.

The Dairy Law (*Acts and Resolves for 1912, Chapter 218*). — The dairy law, so-called, requires operators of the Babcock test, where such test is used as a basis of payment for milk or cream, or for the purposes of inspection, to secure a certificate of proficiency from the Experiment Station. Fifty-one applicants were given the required examination and received certificates. The act requires, also, that all glassware used by licensed operators be tested for accuracy, and so marked. Six thousand and eighty-four pieces of glassware have been tested, of which only 13 pieces were condemned. In addition to the preceding, an annual inspection of machines and apparatus is also required. This inspection was carried out by Mr. J. T. Howard, authorized deputy, who visited 6 creameries, 33 milk depots and 46 milk inspection laboratories. Reinspections on account of repairs ordered will be necessary at nine places.

Miscellaneous Work. — Considerable time is used in making analyses of feedstuffs and dairy products sent in by citizens of the State, and of samples in connection with feeding experiments at the Experiment Station. Waters from wells or springs used as family supplies are also examined.

Considerable time has also been devoted to work not easily reported in terms of statistics, such as giving advice or information, either verbally or through correspondence, relative to feeding stuffs found in the Massachusetts markets, and to the formulating of rations. While such work is more properly an Extension function, an attempt is made to answer such questions where the answer is found in the chemical work with which we are directly concerned.

Testing of Pure-bred Cows for Advanced Registry. — The supervision of advanced registry is taking an increasing amount of time each year, and it is believed that it will be necessary very soon to make other arrangements in order to care for the work more adequately. Not less than nine and as many as sixteen men have been employed in making the two-day monthly tests. For the year ending Dec. 1, 1919, 4,150 two-day tests were reported; for the year just past 5,820 were reported, — an increase of 1,668 over the previous year. The number of cows on yearly test increased in one year from 416 to 519; the number of farms, from 58 to 72.

Summary of Two-day Test Work, December, 1919, through November, 1920.

MONTH.	Number of Supervisors, Whole or Part Time.	NUMBER OF COWS TESTED.						NUMBER OF HERDS VISITED.					
		Guernsey.	Jersey.	Ayrshire.	Short-horn.	Holstein.	Totals.	Guernsey.	Jersey.	Ayrshire.	Short-horn.	Holstein.	Totals.
December, . .	10	166	130	85	4	31	416	31	11	10	2	4	58
January, . .	9	169	114	88	4	39	414	34	12	10	2	8	66
February, . .	16	178	138	79	8	52	455	35	11	10	3	9	68
March, . . .	14	161	128	100	15	50	454	33	12	10	4	9	68
April, . . .	11	161	130	107	19	72	489	32	10	11	4	10	67
May, . . .	13	158	120	106	21	77	482	32	9	11	4	12	68
June, . . .	10	167	118	103	21	89	498	29	10	11	4	12	66
July, . . .	12	197	115	104	23	88	527	40	12	11	4	10	77
August, . . .	12	175	113	107	24	91	510	30	11	11	4	11	67
September, . .	13	189	118	104	26	90	527	33	12	12	4	11	72
October, . . .	11	198	120	103	28	80	529	34	12	12	4	9	71
November, . .	12	190	112	103	28	86	519	35	11	12	3	11	72
Totals, . .	–	2,109	1,456	1,189	221	845	5,820	–	–	–	–	–	820

The short-time tests for the Holstein Friesian Association did not fall off to the extent hoped for; in fact, about 46 more cows were reported than for the previous year. Statistics for the Holstein work follow: —

Number of farms visited,	32
Supervisors employed,	39
Reports turned in:	
120-day,	1
100-day,	1
60-day,	1
30-day,	58
14-day,	13
7-day,	261

NUMERICAL SUMMARY OF LABORATORY WORK.

Samples sent to the Station.

Water,	60
Milk,	344
Cream,	378
Ice cream,	1
Breast milk,	2
Feedstuffs,	145
Fertilizers,	100
Lime products,	6
Soils for lime absorption capacity and organic matter tests,	137
Soils for complete or partial chemical analysis,	20
Arsenic determinations,	2
Vinegar,	7
Insecticides,	9
Cider for soluble copper,	9
Tobacco,	12

Control Work.

Fertilizers,	1,311
Feedstuffs,	1,002

Samples Analyzed in Connection with Experiments.

Milk,	168
Feedstuffs,	114
Fæces,	49
Urine,	14
Dry matter determinations on pot experiments,	288
Nitrogen determinations on pot experiments,	96
Phosphoric acid determinations on pot experiments,	44
Potash determinations on pot experiments,	48
Total,	4,366

REPORT OF THE CRANBERRY STATION.

H. J. FRANKLIN.

Investigational Work.

Insects. — The study of cranberry insect problems in general was continued. In co-operation with Mr. Walter Holmes, the gypsy-moth superintendent for southeastern Massachusetts, tests were made to determine the effectiveness of the open nozzle in spraying to control the gypsy moth on the bogs. General observations were also made concerning the occasional remarkable decrease in severe gypsy infestations during the development of the worms.

Hitherto unknown parasites of the cranberry girdler (*Crambus hortuellus*) were reared. A new control for this pest was developed, — namely, spraying with nicotine sulfate to kill the moths. In connection with this work it was observed that the insecticide was also destructive to leaf-hoppers and spring-tails which usually infest in great numbers the vines of bogs that are not reflowed, and probably reduce their vitality considerably. These tests and observations added materially to the mass of information from which must be developed the most practical program for spraying bogs which have water supplies for winter flowage only.

Tests were conducted to determine what strength of nicotine sulfate is most feasible for use in a spray to kill the moths of the black-head fire worm (*Rhopobota vacciniana*). Satisfactory results were obtained.

The brown span worm (*Epelis truncataria* var. *faxonii*) was unusually prevalent, the moths appearing in great numbers on even more bogs than in 1919. Many requests for advice on the control of this pest were answered, with the result that it did little harm except on a few neglected bogs. Important observations were made concerning the worm counts that precede serious injury by this insect.

The green span worm (*Cymatophora sulphurea*) was also unusually prevalent this season, and it completely destroyed what promised to be a very good crop on several acres in Duxbury. Important new facts about the life history of this species were learned.

By extensive examinations and counts it was found that the egg parasite (*Trichogramma minuta*) of the fruit worm was less prevalent than usual.

Important new observations concerning the habits of the root grub (*Amphicoma vulpina*) were made.

Five field meetings (in Rochester, Carver, Plymouth, Wareham and Sandwich) were held with cranberry growers to demonstrate the use of the insect-collecting net in discovering and determining the severity of certain insect infestations in their early stages. These meetings were planned as a special effort in the control of the gypsy moth, but the other open-feeding caterpillars often found damaging the bogs, such as span worms and army worms, were also discussed. A supply of insect nets had been prepared, and more than five dozen of them were sold to the growers for use on their bogs.

Weather Observations. — Weather observations were made as in previous years, in co-operation with the Weather Bureau, daily reports being telegraphed to the district forecaster in Boston.

A new method of making minimum temperature calculations for frost predicting, based on the Station records of 1913 to 1917, inclusive, was published in the "Monthly Weather Review" by the writer. Further records and studies were made during the season for the purpose of testing and improving this method. In forecasting for the local cranberry growers the method proved accurate enough to be very useful. Heretofore opinions concerning possible frosts have been given, with a few exceptions, to the local growers and those in the town of Carver only, the distribution of the warnings in Carver having been made possible by the generous co-operation of Mr. L. M. Rogers, manager of the Atwood Bog Company. This season, through the courtesy of the New England Telephone and Telegraph Company, arrangements have been made to give out frost predictions in both the afternoon and evening to all the growers on the Cape who want them. This system of distribution was not completed until after the beginning of the fall frost period, but it should prove useful hereafter.

Disease Control. — Extensive further tests of arsenate of lead as a treatment of diseases causing cranberry decay were conducted, with results that strongly confirm those of former years.

Fertilizer Tests. — The fertilizer tests which had been conducted for about twelve years with generally negative results were discontinued.

Varieties. — The study of the characteristics of the cranberry varieties cultivated on the Cape was continued, special attention being given to seed counts. As a part of this work, small plantings of the Pride and Wales Henry varieties were made at the station bog.

Storage Tests. — At the end of the season storage tests were conducted to determine the effect of different containers on the rate of size shrinkage of the sound berries.

Blueberry Work. — Work with the blueberry plantation progressed satisfactorily, much more extensive budding of selected stock being done than heretofore. Satisfactory drainage of the plantation was provided by new construction. The quarter acre of cultivated plants yielded 147 quarts of fine berries, the largest of which were 20 millimeters in diameter. This seems a fair crop, as most of the plants were seedlings only five years old. The fruit was all sold locally at moderate prices.

For cranberry variety studies and the proper development of the blueberry work several acres more of rough land are needed, and an early appropriation should be made for its purchase.

EXTENSION WORK.

As usual, much time was spent in what should be classified as Extension work. This work was made more effective than heretofore through the presentation to the Station, by the Cape Cod Cranberry Growers' Association, of a Ford runabout.

This enabled the writer to visit bogs in distant towns more freely. This extension of the field of operation not only made the Station more serviceable to the growers, but also yielded some valuable results in the way of new observations.

YIELD OF CRANBERRIES.

The Station bog yielded a crop of about 900 barrels, and this fruit sold at good prices, so the Station was more than self-supporting this year.

REPORT OF THE DEPARTMENT OF ENTOMOLOGY.

H. T. FERNALD AND A. I. BOURNE.

Report of Project Work.

The Onion Maggot. — Studies on control of the onion maggot have been seriously interfered with by the reduction of acreage of onions raised, owing to lack of labor in the Experiment Station. Only a small part of the acreage usually available could be obtained for experimental work on this subject, and the tests were less satisfactory for that reason. Such results as were secured, however, were distinctly favorable, and if an unrestricted opportunity to continue the work in 1921 can be arranged, and the year proves to be a "maggot year," it is probable that this project can be brought to an end.

Importance of the Codling Moth. — Studies on the importance and time of appearance of the codling moth have made satisfactory progress. Considerable information has been added to that already obtained, but the results thus far, it must be acknowledged, are rather perplexing. The usual directions as to treatment for this insect include spraying with arsenate of lead three to four weeks after the calyx spray. This time is rather too late for a fungicide spray, which should be applied about two weeks after the calyx spray. If the codling moth spray can be as successfully applied earlier, with the fungicide, a distinct saving will be made. The data thus far gathered are insufficient to settle this point, and the entire project evidently calls for further observations.

Studies on Common Scales. — Observations on the dates of appearance of the crawling young of our common scales have, as stated last year, shown that the original idea of the experiment could not be held to, but another basis for the work has been found and promises to prove sound. If so, the data already accumulated will be of great value. Added to this as collateral items, observations on the dates of appearance of many of our other common insects and of the development of various plants in the spring promise much of interest along the same line.

Tests of Standard Insecticides. — Studies on the burning of foliage by insecticides are drawing toward an end. The results thus far are being tabulated and prepared for publication.

Studies on Digger Wasps. — These studies are progressing, though slowly. The project is a much larger one than was at first supposed, and with little time available for it, any marked advance in a single year is impossible.

The Squash-vine Borer. — This pest has caused a large amount of injury in Massachusetts the last few years, and a study of the insect and methods for controlling it have therefore been taken up this season. It is too early as yet to expect results, but several facts which may prove of value have already been obtained.

The Squash Bug. — This pest has also been studied to some extent the past summer. Work on it will be continued next year.

STUDIES OF SPRAY MATERIALS.

Studies of several materials used in spraying were made during the season, and the results follow: —

Aphicide. — There have been times when nicotine sulfate 40 per cent was not available on the market, owing either to an unusual demand or faulty distribution. At such times an effective substitute to use against aphids is desirable. Kerosene emulsion, employed for many years for these insects, is troublesome to make, and frequently fails to give good results. Anything which is an effective aphicide and also reasonable in price is, therefore, desirable to add to our list of insecticides.

Aphicide is a new material manufactured as a substitute for the nicotine sprays in controlling plant lice, and it was therefore tested during the season. Two samples were provided, one apparently more concentrated than the other. Both were clear liquids, the (presumably) weaker being almost colorless, the other having a slight yellowish-brown tinge. Both mixed easily with water, and showed little tendency to separate out of the mixture on standing. The directions provided by the manufacturers for mixing called for ¾ to 1 per cent of the material and ½ per cent of soap. The formula would therefore be: —

Aphicide, ...	¾ to 1 part
Soap, ...	½ part
Water, ...	98½ to 98¾ parts

Such accuracy as this proved unnecessary, and various strengths of the material were tested, as the formula just given was too weak to kill the aphids. At 5 and 6 per cent, both grades of Aphicide proved very efficient, but were injurious to tender foliage. An increase of the amount of soap was then tried, and it was found that 1 per cent of soap with 4 per cent of Aphicide gave very satisfactory results without injuring the plants.

The conclusions reached as a result of these tests are that 4 parts of Aphicide and 1 part of soap in 95 parts of water make an effective material to use against aphids, and will not, at least under ordinary conditions, injure foliage.

Sulco V. B. — Tests of this material were undertaken at the request of one of the county agricultural agents who was much impressed by the comprehensive claims made by its manufacturers, these being that it is an insecticide, a fungicide and to some extent a repellent.

The material is a thick, heavy, oily substance readily miscible with water, from which it does not separate to any great extent until after standing for about twenty-four hours. It is claimed to be a mixture of a fish oil, sulfur and carbolic acid. The directions for application supplied by the manufacturers were to mix 1 part of the material with 25 parts of water for use against aphids, 1 to 30 for mites on evergreens, 1 to 100, with 2 pounds of arsenate of lead powder, against cucumber beetles, and 1 to 20 for ants in lawns.

Tests were made with this material for the control of ants, of plant lice, and of mites on evergreens, as a repellent for adult squash bugs, and to kill the eggs and young. Its effects on foliage, alone and with arsenate of lead, were also tested. In these tests the directions for preparation were followed until the necessity for a change became evident. As a repellent against ants, it killed a few which were actually hit by the material; the others were not affected, nor was the prosperity of the colony as a whole checked perceptibly. Grass and other plants around the nests were killed. Against squash bugs it showed no repellent value and did not kill the eggs. It killed the young bugs, but when used strong enough to do this it killed the squash leaves also. Against mites on evergreens it proved fairly effective, but when any large percentage was killed, its strength had been necessarily increased to a point where it was not safe for the leaves. In the case of plant lice the strength recommended proved dangerous to the foliage of the plants, though killing the lice. Further tests, diluting the material at the rate of 1 to 60, and even 1 to 70, gave excellent results with the insects and no leaf injury.

Mixed with arsenate of lead the same results were obtained, and the conclusion was finally reached that Sulco V. B., at the strength recommended by its makers, is unsafe for use on most kinds of foliage; and that, when diluted to a point where it will not cause foliage injury, it is ineffective as an insecticide except for plant lice. For these pests, however, it can be diluted to a point where the leaves will not be injured and still kill the insects.

White Arsenic as an Insecticide in Bordeaux Mixture. — Some recent experiments, reported by Sanders and Kelsall (Proceedings of the Entomological Society of Nova Scotia, No. 5, for 1919), using arsenic instead of arsenate of lead or arsenate of lime in Bordeaux mixture, made it seem desirable to give a little attention to this subject. White or common arsenic costs less than the other arsenicals, "is the most concentrated form of arsenic, and consequently suffers least from freight rates, occupies less space, and entails the handling of less weight." If it can be used as safely and effectively as the other insecticides in combination with Bordeaux mixture, it should largely replace them, at least for some purposes.

Tests of this mixture on potatoes were made during the season, a very finely divided sample of arsenic being used. To prepare 50 gallons of the spray, half a pound each of white arsenic and fresh, unslaked lime were used. The lime was slaked in just enough water to keep the action brisk, and the arsenic was slowly added during the slaking and thoroughly mixed in. After the slaking had been completed, water sufficient to make 5 gallons was added, and the whole thoroughly stirred. A sack containing 5 pounds of copper sulfate was then suspended in the mixture and shaken frequently until the copper sulfate had entirely dissolved. About a day later, when ready to spray, 5 pounds of lime were slaked in a few gallons of water, and diluted to make 25 gallons. The other mixture, prepared the day before, was also then diluted with water to make 25 gallons, and the two lots were poured together, stirred and sprayed.

It is evident that as a result of this work the material sprayed is no longer arsenic itself. It is probable that it, at least in part, combines with the copper, forming copper arsenite, which alone is often very injurious to foliage, but in this case is rendered non-injurious by the lime present. The Bordeaux mixture made in this way was green in color. Its suspension did not quite equal that of ordinary Bordeaux-arsenate of lead, but it adhered to the leaves fully as well. No leaf injury was observed in any case where this material was used, and good protection from potato insects was secured. No blight appeared on the potatoes.

The amounts of lead arsenate, both in dry form and as paste, required to furnish the same amount of poison (expressed in terms of metallic arsenic) as was supplied by one-half pound of white arsenic, together with the relative costs of the three materials, are as follows: —

MATERIAL.	Metallic Arsenic (Per Cent).	MATERIAL REQUIRED TO FURNISH EQUAL AMOUNTS OF METALLIC ARSENIC.	
		Pounds.	Cost.
White arsenic,	75	½	$0 11[1]
Dry lead arsenate,	21	2	84
Lead arsenate paste,	11	4	1 00

[1] In 50-pound lots.

Evidently the white arsenic is by far the cheaper material to use. There is a little extra labor in preparing the Bordeaux mixture with arsenic as compared with the use of the other materials, but in practice this proved to be only a few minutes.

Where very finely divided arsenic can be obtained, therefore, its use in homemade Bordeaux mixture seems to be profitable, at least as a spray for potatoes.

Dry Sulfides as Substitutes for the Lime-sulfur Concentrate. — Dry sulfides have appeared on the market in recent years as substitutes for the liquid lime-sulfur. Reports as to their value have been conflicting, some claiming that they give good results, while others consider them worthless. The difficulties with the concentrate are several. Being a liquid it is more inconvenient and more costly to ship, and the material itself will not keep long if exposed to the air. It is also spoiled by freezing. These difficulties are all avoided by the use of dry materials, and if their effectiveness as insecticides is equal to that of the concentrate, the latter will surely be entirely discarded after a time.

This department has no opportunity to carry out field tests of these materials, but with the aid of the Chemical Department of the Station has made some studies on their composition.

The lime-sulfur concentrate contains calcium thiosulfate and calcium polysulfide. It is the general belief, sustained by experimental tests, that the polysulfide is the active agent of the mixture. The relative efficiency of these compounds is best measured in terms of their sulfur content. An investigation was made of the amount of polysulfide sulfur present in the lime-sulfur concentrate, in dry lime-sulfur, in barium tetrasulfide (B. T. S.), and in soluble sulfur (sodium polysulfide). In the comparisons which follow, spray made from the lime-sulfur concentrate, strength 1 to 8, was taken as the standard: —

MATERIAL.	Polysulfide Sulfur Present (Per Cent).	50 GALLONS SPRAY MADE FROM MANUFACTURER'S DIRECTIONS.			50 GALLONS SPRAY, STANDARD STRENGTH.	
		Amount of Material used.	Cost.	Polysulfide Sulfur (Per Cent).	Amount of Material required.	Cost.
Lime-sulfur concentrate.	25.00	5 5/9 gallons	$1 10	3.50	5 5/9 gallons	$1 10
Dry lime-sulfur,	49.86	10 pounds	1 30	1.18	30 pounds	3 90
Barium tetrasulfide	43.19	11 pounds	1 54	1.12	34 pounds	4 80
Soluble sulfur,	47.97	12½ pounds	1 25	1.41	31 pounds	3 10

Evidently, then, the concentrate is the cheapest material by far. It is also evident that at the strengths advised by their makers, the other substances will have much less of the active agent present, and should be far less effective than the concentrate.

On the other hand, many who have used these materials report good results. Is this due to defective observations, prejudice in favor of materials so easily handled, or is it correct? If the latter, the question at once arises whether the concentrate is not stronger at 1 to 8 than is really necessary, and whether the other weaker materials are not, after all, strong enough for the work. To answer this, extensive field experiments under all kinds of conditions will be needed. It is possible that for years we have been using the concentrate stronger than is necessary, and that a greater dilution, bringing the percentage of polysulfide sulfur per barrel of spray down from 3.5 to about 1.25 per cent, would give equally good results. If this should prove to be true, the relative costs of the different materials would not be greatly affected, however, and the concentrate would in any case be the cheapest of the four by a considerable amount.

Extension Work.

There has been the usual demand upon this department for work of an Extension nature. Rather more than a quarter of the entire time of one man has been required to attend to duties of this kind. Correspondence, telephone and office calls, visits to places where assistance was needed, fumigation work, the preparation and demonstration of exhibits at fairs and during Farmers' Week, have made up this total.

The College Apiary.

The care of the College Apiary was under the supervision of Mr. J. L. Byard until about the middle of July. Unfortunately, Mr. Byard was taken ill at that time, and during the remainder of the year his work was necessarily carried on by the men in this department. Had this not been done, the colonies of bees would have been lost and the beekeeping work would have come to an end, but the time required to prevent this loss to the College greatly reduced the amount of experimental work it was possible to do. Mr. Byard's death the last of November means the loss to the College of a faithful and industrious worker who had been for a number of years connected with the apiary here, and who had given liberally of his time and energy to the welfare of the work.

Insects of the Year.

While many kinds of insects were actively at work during the year, no outbreak such as that of the bean caterpillar in 1919 developed in the State in 1920.

As a matter of record it may be noted here that the gypsy moth made its appearance in Amherst in 1920 for the first time, but only in small numbers. Pelham and Belchertown are now also infested.

REPORT OF THE DEPARTMENT OF HORTICULTURAL MANUFACTURES.

W. W. CHENOWETH.

This department has but recently been organized, and because of crowded conditions in the laboratory, meager equipment and lack of efficient research assistants, the investigations carried on thus far are only preliminary to larger things to be taken up later. However, much valuable work has been done along the following lines: —

Jelly Making. — This is being studied from the standpoint of economic production. Results show that by proper handling of the fruit the yield may be increased two to three times the amount generally obtained by household methods; also that jelly of highest quality is produced where the amount of sugar is reduced to one-half or less than one-half the amount generally used. This fact has been of tremendous importance in recent years because of the sugar shortage.

The Economic Values of Varieties of Fruits for Manufacturing Purposes. — These investigations include both the small fruits and tree fruits. There is no doubt that varieties of fruit vary in their natural adaptability for canning and for the manufacturing of many fruit products.

Fruit Juices. — The manufacture and preservation of fruit juices for beverage purposes is an interesting and important problem. Many thousands of dollars worth of fruits are wasted annually in Massachusetts while our markets are supplied with fruit juices from the fruit plantations of the West. The work here also includes studies of improved methods in the home manufacture of vinegar.

Canning. — Study is being made of those factors that influence the processing period of canned foods, as well as studies of varieties of fruits best adapted to canning.

Cranberries. — The utilization of poor-grade cranberries is being studied this season.

When the necessary facilities are provided, the department plans to intensify and enlarge the above projects, and in addition to start further investigations looking to the solution of other perplexing problems connected with the preservation of fruits and vegetables.

REPORT OF THE DEPARTMENT OF HORTICULTURE.

J. K. SHAW.

There are at present four projects dealing with pomological questions under active investigation: —

The Interrelation of Stock and Scion in Apples. — The orchards devoted to this project have made satisfactory growth, and the usual records have been taken during the year. Some tabulations have been made which indicate that the stock materially modifies the growth of the tree, but these must accumulate for several more years before safe conclusions may be drawn.

The Genetic Composition of Peaches. — The orchard planted for this work has made fair growth, and several additional varieties desired have been secured. It will be a year or two yet before the trees come into bearing so as to permit extensive pollination work. A small quantity of pits of known parentage was planted in the spring of 1920, but for some unknown reason none of them grew.

A Study of Tree Characters of Fruit Varieties. — Last year some work was done on the study of variation and its relation to the theory of senility, and it is proposed to give some more time to this next year. Plans are made for a somewhat extensive study of leaf characters, which it is hoped may be completed during the season of 1921.

Pruning Young Apple Trees with Special Reference to Head Formation. — This orchard has made splendid growth, and is showing substantial results from the different methods of pruning. Unfortunately it was not pruned in the spring of 1920, and this omission will have an effect on the future behavior of the trees. The pruning in the spring of 1921 will, so far as possible, correct this omission.

Temperature Observation Work. — A large amount of data has accumulated from this work, and is now being tabulated and studied as to its relation to peach and apple growing.

Several new lines of work are under consideration in the hope that they may be undertaken in the near future. These center around the general question of soil management and fertilization of apples, peaches and bush fruits. Means of promoting the bud hardiness of peach should have some consideration, and we could well undertake some further work in pruning.

REPORT OF THE MARKET-GARDEN FIELD STATION.

H. F. TOMPSON.

Report on Project Work.

Manure Economy Test. — This was somewhat upset by the late spring, shortage of labor and insect injury, but the records show consistent progress.

Barium-Phosphate Test. — In the second season's test Barium-Phosphate has shown no particular benefit over acid phosphate as a carrier of phosphoric acid, and in several instances has seemed less efficient. Two tests were carried out, — one similar to that of 1919, the other with complete fertilizers, Barium-Phosphate being substituted for acid phosphate in one mixture. The crops under test were beets, carrots, cabbage, lettuce and spinach.

Martha Washington Asparagus. — The one-quarter acre plot of this asparagus has developed in a satisfactory manner. The first cutting was made the past season. Wide variation in size and yield is noticeable in different plants. Plans are under way for tests of individual plants to determine yields and characters, with a view to an elimination of the less productive units.

Limited Variety Tests. — These tests have proved of much interest, and point to some avenues of investigation which are projected for the future. The strain and variety test of tomatoes has been of much value, and indicates the possibility that ecological factors are of more importance for this crop than is commonly supposed.

Greenhouse Cucumbers. — In the greenhouses there has been a second test of cucumbers conducted in a similar manner to that of 1919. The cold, cloudy spring interfered with this project, more particularly as it was necessary to depend upon heat from the sun, the heating plant not being completed. Ten strains of the greenhouse type of cucumbers, mostly from local growers, were under test, to determine the comparative yields. The first planting was made on the 3d of April, and picking did not begin until late in June. A bad attack of anthracnose greatly damaged the test. The total yield per plant averaged about one-half that of 1919. The variation in yield between strains, so far as this test indicated, was so slight as to leave the choice to market quality. In this there was considerable difference. As the Boston market calls for a long dark green type, the Belleville strain appeared superior, and the yields were approximately the same as for some of the shorter varieties.

Greenhouse Lettuce. — The project of improvement of lettuce for greenhouse production was started in the fall of 1920, with a test of some thirty-five strains and varieties of lettuce, collected from local growers and leading seedsmen in this country and abroad. By the 30th of November the test had not proceeded far enough to show results.

INCREASE IN EQUIPMENT.

The equipment for experimental work has been increased by the completion of the heating plant and oil-burning apparatus, also the purchase of two additional recording thermometers. Each greenhouse is now equipped with self-registering thermometers, and a complete record of night and day temperatures is being filed.

REPORT OF THE DEPARTMENT OF METEOROLOGY.

J. E. OSTRANDER.

The work of this department has been continued along the lines of previous years without material change. The character of the work requires that after a definite form of records has been adopted it should be adhered to without much change if the records of different years are to be compared.

The regular semi-daily readings of the several meteorological instruments have been made and tabulated, and the self-recording instruments kept adjusted and running without any material stoppage. As some of the instruments have been in constant use for more than thirty years, frequent adjustments have been necessary. The time has come when a beginning should be made toward a renewal of the more important instruments. The more important records have been tabulated in the same form as when the station was started, so that comparisons from year to year may readily be made. The monthly bulletin of four pages has been prepared and published promptly at the close of each month.

The usual voluntary observer's reports have been sent to the Boston office of the United States Weather Bureau each month, and during the growing season weekly reports on crop conditions, precipitation, temperature and sunshine have been furnished the same office. Arrangements have been made to furnish the usual snow and ice reports to the Weather Bureau, as the snow and ice bulletin is to be issued again after having been temporarily discontinued during the war period.

Many requests for specific data regarding the weather on certain dates have been received and answered during the year. The information asked for usually related to temperature at the time crops may have been injured in shipment, unusually heavy precipitation, wind direction or wind movement, or the general character of the day. This particular feature of the work of the department has greatly increased in the last few years.

REPORT OF THE DEPARTMENT OF MICROBIOLOGY.

C. E. MARSHALL.

The Experiment Station work in this department may be enumerated under three heads: —

Food. — The only workers in this field for the past year have been two graduate assistants giving half time, — Mr. Conrad H. Leiber and Miss Mary Garvey, the latter retiring from the work Oct. 1, 1920. Owing to this situation progress lags. Dr. Arao Itano, who gave some time to food study during the year, with the assistance of Miss Garvey, concluded a phase of this field of study, report on which will be withheld until another aspect of the subject is covered. The study in hand is a continuation of that of last year.

Dairy. — Although no recognition is given to the dairy studies by the Experiment Station, it may not be amiss to mention the fact that Mr. James Neill and Mr. R. C. Avery are engaged upon two very interesting themes out of which much is anticipated.

The past year two articles have been published in "Dairy Science," giving the results of the department's work on the De Laval studies: —

"Clarification of Milk," by Charles E. Marshall and E. G. Hood, together with Arthur N. Julian, S. G. Mutkekar and Max S. Marshall, in Vol. III, No. 4, July, 1920.

"An Association Study of *Streptococcus Lacticus* and *Bacillus Subtilis*," by Max S. Marshall, in Vol. III, No. 5, September, 1920.

Another article has been prepared by Max S. Marshall dealing with the possibilities of the clarifier, which furnishes a basis for its future development.

Soil. — Progress has been made in the study of microbial changes of organic matter of the soil. A step in the investigation of the problem, carbon dioxide determination (started in connection with Mr. L. C. Whitaker, who resigned July 1), has been developed and is now ready for publication. The study of the microbial decomposition of cellulose has been started in association with Mr. J. R. Sanborn.

Miscellaneous Work. — The analytical work of the department may be summed as follows: —

Bacterial counts on milk samples,	815
Water samples tested,	12
Medical specimens,	125

Legume cultures to the number of 299 were distributed.

REPORT OF THE DEPARTMENT OF POULTRY HUSBANDRY.

H. D. GOODALE.

The Elimination of Disease.

The chief item of interest in the work of the year is the drive made against disease, especially paralysis. The plan consisted in hatching from the old stock as usual, but taking the day-old chicks directly from the machines to a quarantined range where they were grown to maturity. At the close of the breeding season all old stock was sent to market, and the plant thoroughly cleaned and disinfected. In October the young stock was transferred to the renovated plant. The experiment was completely successful as far as the quarantined range was concerned, but a report on the remainder of the experiment cannot be made until more time has elapsed.

Project Work.

The fusion of the high-producing line and the non-broody line is complete. Broody birds still appear and doubtless will continue to appear for several years. Judging from this fall's performance, the egg production of this strain is likely to exceed that of any previous flock. Much more rapid progress could be made in the development of the high-producing strain if a thousand pullets could be trap-nested each year for the next two or three years.

A considerable amount of work of technical interest has been done on the reproductive organs.

Tillson Farm.

The assignment of the Tillson Farm to the Poultry Department will remove many hindrances to the progress of the experiments as soon as the transfer is completed and the farm is properly equipped.

DEPARTMENT OF VETERINARY SCIENCE.

JAMES B. PAIGE, D.V.S.

With the rapid multiplication of activities in the department during the past four or five years, the administrative work has increased to the point where it requires the attention of the head of the department for the greater part of the time for which he is responsible to the Experiment Station. The direction of the activities of the members of the staff, the preparation and development of the projects, conferences, keeping of accounts, etc., leave little time for the prosecution of investigational studies.

Diagnosis.

For many years it has been the practice in the department to invite the stockmen throughout the State to send in material from sick or dead animals for examination and diagnosis. This material comes from all species of farm animals. It frequently furnishes the best of specimens for study and use in the classrooms and laboratories. It also enables the department to keep in touch with the different diseases of farm animals throughout the State, and to locate the existence of an unusual disease in a particular locality. A report giving details of post-mortem findings, the cause of the trouble, nature of the disease and means of prevention and treatment is sent to the one sending in the material. By this means we feel that the department is rendering a valuable service to the stock owners of the State, along the line of disease eradication and control.

CORRESPONDENCE.

From the preceding paragraph it is evident that a large amount of correspondence is necessary in connection with the diagnosis work. Each letter has to be of a personal nature, as hardly any two cases are exactly alike. In addition, many letters are received asking for information and advice relative to the treatment of diseases of the different species of farm animals. Conferences with stockmen from different localities frequently follow correspondence.

CONTROL WORK.

Nearly all of the more serious contagious and infectious diseases of farm animals are placed by law under the control of the Division of Animal Industry of the Department of Conservation. Among them may be noted bovine tuberculosis, glanders and mange of horses, hog cholera and others. There are some, however, belonging to the class, such as fowl cholera, fowl typhoid and bacillary white diarrhea, that do not engage the attention of the Division of Animal Industry.

Under an act of the Legislature passed in 1919 this department was given a small appropriation for the purpose of testing poultry for the elimination of disease. The entire amount appropriated, $3,000, has been expended in testing fowls for the diagnosis and control of bacillary white diarrhea. The act provides that a fee not to exceed 7 cents per bird may be charged for each bird tested. From Dec. 1, 1919, to Dec. 1, 1920, there were tested 19,982 birds, with receipts of $1,398.74. In addition to these receipts the department provided 12,810 leg bands for identification of birds from which blood samples were taken, for which the owners paid $64.05, making the total receipts $1,462.79. Deducting this amount from the amount of the appropriation, we have $1,537.21 as the total cost to the Commonwealth for this particular line of work.

Under the existing conditions of high cost of materials, travel, maintenance, etc., $3,000 was hardly sufficient to carry on the work to the satisfaction of all parties interested. In fact, it became necessary to suspend operations through the three summer months. Under normal conditions there are but few demands for testing in summer. The hatching season is over and the poultrymen have not made up their matings for the next season. With a sufficiently large appropriation to carry on the work continuously throughout the year, however, the summer months could be used to very good advantage by the department in visiting the flocks tested earlier in the season and checking up the work, a procedure necessary in any effort directed toward the suppression and elimination of any animal disease.

It is to be hoped that the General Court at its next session will considerably increase the appropriation under the special act of May 23, 1919, thereby enabling us to carry on the work continuously throughout the year, to extend the field of operations to include a larger number of flocks, and thus to increase the services of the department for the benefit of the poultry keepers of the Commonwealth.

INVESTIGATIONS.

Bacillary White Diarrhea in Chicks; a Study concerning the Diagnosis of Bacterium Pullorum infection in the Domestic Fowl. — This project is being conducted as an Adams fund study, and the details are in charge of Dr. George Edward Gage. The laboratory studies of the problem have been completed, and a start has already been made in the preparation of the manuscript for a bulletin, which, it is expected, will be ready for the printer early the coming year.

Studies relative to Hog Cholera; its Complications, Prevention and Inherited Immunity. — These investigations are being carried on with a herd of from 75 to 100 hogs kept by a farmer here in Amherst and fed upon raw garbage that is collected about town, which, it is reasonable to infer, is liable at any time to be contaminated with pork scraps from localities where hog cholera exists. It is a well-recognized fact that many of the outbreaks of hog cholera occurring among Massachusetts hogs have their origin in fresh pork scraps that find their way into garbage. The work already done in connection with this experiment has shown beyond a doubt that hog cholera of the usual type can be prevented by the use of anti-hog cholera serum and virus. There is also strong evidence that one application of the simultaneous treatment to weaned pigs possessing an inherited immunity is sufficient to protect the animal against the usual type of hog cholera throughout its life. The usual practice, at present, is to give weaned pigs a single dose of anti-hog cholera serum, and then, at the age of twelve to fourteen weeks, to give both serum and virus. If it is found that the simultaneous treatment at the weaning time is sufficient to protect throughout the life of the pig, the expense and trouble of two treatments may be avoided.

SPECIAL PROBLEMS.

Early in the year two special problems came to the department, each of which demanded immediate attention. A number of cows at the farm barn calved prematurely, and it was thought that contagious abortion had gained a foothold in the herd. At the poultry plant disease was ravaging the flock, as many as ten to fifteen birds being found dead on successive days. The condition became so acute that the farm committee of the Board of Trustees met to consider ways and means of dealing with the situation. As a result of their deliberations it was decided to procure the services of a graduate veterinarian to take the matter in hand, under the direction of the head of the Veterinary Department. Dr. John B. Lentz, a graduate of the Veterinary Department of the University of Pennsylvania, who had been a member of the staff of the Veterinary Department of the Experiment Station in charge of the poultry disease elimination work, and who, after his discharge from the service, had resigned his position, was secured to come to the department to take charge of these two special problems. He reported for service early in February, and at once began an investigation of each problem.

It was found at the farm barn that a considerable number of cows had given birth prematurely, but there was no conclusive evidence that the contagious form of abortion existed in the herd. A considerable number of cases of sterility, vaginitis, metritis and other complications of abortion existed in the herd. All of these conditions were taken in hand, and the individual cows given appropriate treatment. Although the work is still in progress and cannot be completed until the time arrives for the next crop of calves, a marked improvement as regards the premature births and complications is to be noted at the present time. Cows that have not been bred successfully for many months are in calf, with every indication that they will carry the fœtus the full period of gestation.

Conditions at the poultry plant were far more serious than at the farm barn. A large number of birds showed symptoms of disease and unthriftiness. When the Veterinary Department was placed in charge of the poultry plant, early in February, it seemed probable that by appropriate methods of treatment of the entire flock of about 2,000 birds, it might be possible to eliminate the disease factor without resort to destruction of the entire flock. It soon developed, however, that we were able to make but little progress in arresting the spread of disease. After consultation with the representatives of the poultry staff, and acting largely upon their statement that the stock on the plant was not entirely satisfactory from the poultry husbandry point of view, it was decided to completely eliminate the old flock and clean and disinfect the premises, leaving them vacant for as long a time as possible before bringing a new flock onto the place.

To provide birds to take the place of those destroyed, eggs from the tested, healthy birds then on the plant were saved, incubated in sterile incubators, the chicks taken from the incubators in sterile baskets to a tract of land in North Amherst upon which no birds had been kept for years, and there raised under the direction of persons in no way in contact with the infected College plant. By this method about 2,700 healthy young birds were raised to take the place of the old, diseased flock that had been kept at the College plant.

As soon as all birds on the College plant had been disposed of early in July, a vigorous clean-up campaign was started. All houses and yards were cleaned, fences removed, yards plowed, etc. After the rough cleaning had been done, every building, with equipment, was thoroughly disinfected with a strong solution of a coal-tar disinfectant applied by means of a power spray pump, which made it possible to drive the solution into the smallest cracks and crevices. After plowing and harrowing, the yards were heavily limed, leveled and seeded. In those buildings where disinfectant solutions could not be used satisfactorily, sulfur fumes were used in combination with the liquid disinfectant to insure a perfect destruction of all infectious matter.

Early in October the clean-up work of the Veterinary Department having been completed, an inspection of the poultry plant was made by the farm committee of the Board of Trustees, who reported everything in a satisfactory condition. At this writing it is particularly gratifying to receive from Dr. Goodale, who is in immediate charge of the flock at the College poultry plant, the following: —

> It is a pleasure to know that we have, thus far, no infectious diseases. Our mortality, aside from purely physical causes, has been practically nothing.

BULLETIN No. 195.

DEPARTMENT OF BOTANY.

TOBACCO INVESTIGATIONS.

PROGRESS REPORT, INCLUDING MISCELLANEOUS OBSERVATIONS ON TOBACCO.

BY G. H. CHAPMAN.

Introduction.

The production of cigar leaf tobacco has been for many years a very important agricultural industry in the Connecticut Valley, and in 1916 there were approximately 9,000 acres under cultivation in the Massachusetts section alone. By far the greater part of this was of the variety known as Havana, but some Broadleaf, shaded Cuban, and Sumatra were also grown. The value of the crop was estimated at, roughly, $3,600,000.

It can be seen from the above that the gross income derived from the growing of tobacco in Massachusetts is very large, and must of necessity be a very important factor in the regional community prosperity.

The successful raising, curing, and packing of tobacco is, as is well known, an art in itself, and very difficult of uniform attainment. The tobacco plant is very susceptible to comparatively slight changes of environment, and to grow tobacco successfully for a long period of years on the same soil requires, of necessity, extremely close observation and skill in agricultural practices. That success does not always attend the growers is more or less evidenced by the report alleging that the average yield in Massachusetts is falling off, and also that the percentage of wrapper leaves in crops is decreasing.

The season of 1915 was particularly unfavorable for the development of tobacco, and, as a consequence, the growers requested that experimental work be carried on by the station relative to ascertaining the fundamental underlying cause or causes of the apparent deterioration of the crop. No funds were available to carry on this work until the late summer of 1916, when an appropriation was made for this purpose. The collection of data relative to crop conditions and other phases of agricultural practice was commenced at this time with a view to outlining experimental field and laboratory work for the ensuing years.

It has seemed unwise to make a yearly report until the data of at least two years were available, and therefore the present report includes the preliminary observations made during the latter part of 1916, and a discussion of the results obtained from the different lines of experiment suggested by these findings. These will be treated under their proper headings in the body of the report, with a general summary of conclusions and recommendations following.

Preliminary work was undertaken so late in the season that it was impossible to collect first-hand data on seed-bed conditions. The work was therefore confined to making a survey of the crop and soils in general, with a view to obtaining accurate information regarding the situation. After compiling and correlating these data it was planned to establish in 1917 experimental plots in different sections, and by various treatments endeavor to produce a favorable tobacco condition in the so-called "sick" soils. The problem is not primarily one of soil fertility, as it is generally true that crops other than tobacco — such as onions, corn, etc. — make a very luxuriant growth on the "sick" tobacco soils, and this often without additional fertilization.

Investigations necessary.

From the results of our study of 1916 conditions, it was apparent that the questions involved required the undertaking of several lines of investigation in order to reach a satisfactory solution. Undoubtedly it may be found necessary to change or modify the various experiments as time passes, but there are certain questions which should be answered as soon as possible. Among the more important are the following: —

1. Is the average yield of tobacco gradually falling off from year to year, generally, throughout the valley?
2. Is the quality of the tobacco produced inferior to what has been the average quality?
3. Has the weather factor been a primary controlling factor in production, — especially in later years, — and what limits are permissible for profitable production? (This hardly seems necessary of demonstration.)
4. Is there a correlation between weather factors and diseases, such as root-rots caused by *Thielavia basicola* and other organisms?
5. Aside from the general decrease in crops in 1915–16, and to a lesser extent in 1917, what is the cause of the soil "sickness" on some fields, or parts of fields? Is it due to a parasite, or is it due to improper fertilization and cultural methods?
6. Is there any correlation between the fertilization methods and soil treatment, and the activity of the root-destroying organisms? In other words, have we got some of our fields into a condition which favors the

development of the disease-producing organisms, and which, at the same time, is unfavorable for the optimum growth of the tobacco?

7. What corrective fertilization and cultural methods may best be employed in the latter instance?

Briefly, the investigation may be divided into three main parts, as follows: —

1. *A study of the meteorological factors as related to the growth of tobacco.*
2. *A biochemical study of the soils of normal and "sick" fields, including fertilization experiments.*
3. *A study of the micro-flora and micro-fauna of normal and "sick" soils, including those forms found to be parasitic on tobacco.*

Is the Tobacco Crop actually failing?

It has been repeatedly stated that the average yield per acre of tobacco in Massachusetts is decreasing gradually, and has been so doing for the past ten or fifteen years. This, if true, would be very alarming, and would indicate a widely distributed, serious situation due to parasites or to improper cultural methods. The following data will show the situation as it really is. Some years ago the United States Department of Agriculture, through its Bureau of Statistics, began reporting various data regarding the principal crops of the United States. Tobacco was included, and the following data have been secured from the annual figures as published in the various Year Books of the Department.

The average yield of tobacco in Massachusetts from 1870 to 1910 is calculated as 1,580 pounds per acre. At present this would seem a rather high figure, as the acreage devoted to shade-grown Cuban has increased in the past ten years, until in 1918 approximately 1,100 acres were devoted to this crop out of a total acreage of some 9,000. The yield of shade tobacco is much less than field-grown, not averaging over 1,000 pounds per acre, and this low yield of the Massachusetts acreage would of necessity, reduce the average yield, if yield is calculated on total acreage. However, as no other figures are available, the above-mentioned average is taken for the period 1870 to 1910.

The yield per acre is plotted in Fig. 1, and is self-explanatory. The straight broken line indicates the average yield. The heavy black line represents the seasonal variation.

It is at once apparent that until the disastrous seasons of 1915 and 1916 the yield over a period of fourteen years was, with four exceptions, well above the average, and two of these years, 1902 and 1913, were only slightly below the average. If we average the yields as plotted for the eighteen years we find that, even with the exceedingly low yield of 1915 included, the average yield for the period has been 20 pounds above the average yield calculated for the forty-year period of 1870–1910, — namely, 1,580 pounds.

It is only too true that the figures available are based on estimates which are, perhaps, somewhat at variance with the actual facts; but in any case the factor of error would be identical from year to year, and the general comparative results may be considered trustworthy.

The yield has fallen off seriously only in 1915, and to a lesser extent in 1917; but in spite of these low yields the average yield of tobacco in the period 1900–18 has been above the average of the forty-year period 1870–1910.

There is no justification for the statement that the yield of tobacco on Massachusetts fields has been decreasing *gradually* for the past ten years; but, on the contrary, in spite of the exceedingly low yield of 1915 the calculated average is being maintained. If, however, we consider only the yields of 1915, 1916, 1917, and 1918, it is true that a yield below the average will be found; but some of these seasons have been admittedly unfavorable for tobacco, from the meteorological standpoint, and high yields could not be expected. Also it is incorrect, or at least misleading, to base a statement of *general* yield on so few years' data. The same conditions meteorologically have in the past produced almost identical results, as will later be pointed out.

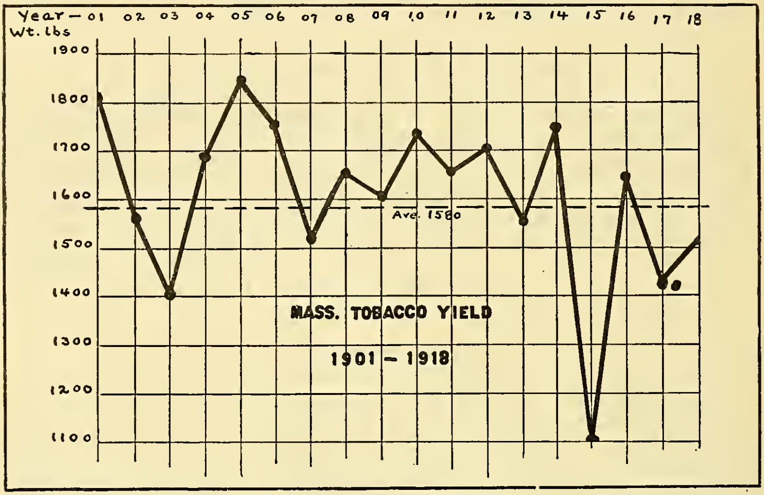

Fig. 1.—Average yield per acre of Massachusetts tobacco from 1901 to 1918, inclusive. The horizontal dash line indicates the average yield from 1870 to 1910.

Weather Factor in Tobacco Growing.

In general, it may be stated that the first half or more of the growing season of 1916 was decidedly unfavorable to the growth of tobacco. Conditions improved from shortly after mid-season until the crop was harvested, and a rapid and apparently satisfactory growth was made. The leaf was of good size and color, but although seemingly in good condition, was inclined — as later developments proved — to run rather light in weight. There was a tendency on the part of many growers, resulting perhaps from their experiences in 1915, to harvest the crop before it was mature; whereas, as a matter of fact, the leaf matured in general rather late in 1916. This factor undoubtedly influenced somewhat the character and weight of the leaf.

It is a self-evident fact that rainfall, temperature, sunlight, humidity, etc., are very important factors in the normal growth of any crop, and perhaps exert a greater influence than usual in the case of tobacco, which is particularly sensitive to slight environmental changes. The season of 1915 was one of very heavy rainfall, as was that of 1916; therefore, as a means of comparison of conditions, the rainfall of 1916 has been plotted with that of 1915, and with a so-called "dry" year in which the crop was of good weight and quality. Fig. 2 shows the rainfall in inches week by week from June 1 to September 1, the variation from the normal, and the yield for each of the years. The correlation of excessive moisture and low yield is certainly very marked; also the converse: subnormal rainfall, well distributed, with a high yield.

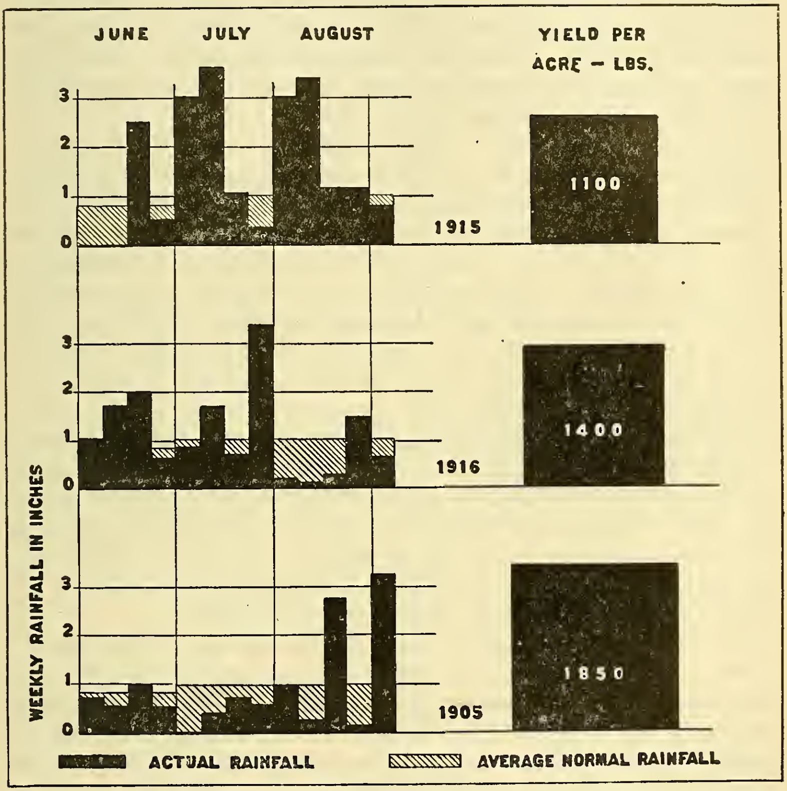

FIG. 2.—Comparison of actual rainfall and yield with normal rainfall for 1915, 1916, and 1905, a so-called "dry" year.

It will be noted that the season of 1916, as a whole, was very wet, with excessive rainfall occurring during the first two-thirds of the growing period. The season of 1915, which was so disastrous, was even more wet; but a reversal of the 1916 conditions is found, most of the rainfall occurring during the last two-thirds or half of the season, when the crop was going through its period of greatest growth, and maturing. The season of 1905, while rather dry, produced many fine crops of tobacco (although they were later damaged by pole sweat), and it will be noted that the rainfall was low; in fact, the precipitation was below normal in many of the weeks and, as a whole, the season would be considered a droughty one. The fact that the last week or two were very wet, and consequently interfered somewhat with harvesting, does not in any way lessen the importance of the statement that the crop was very large. The quality, however, was slightly lowered.

There is no question but that the excessive precipitation of the two seasons first mentioned reduced the weight and quality of the crop; but its general effect was much less in 1916, when most of the excessive rains occurred in the first half of the growing season. These checked early growth in the field, but a subsequent return to normal, or thereabouts, in August allowed of a rapid development in the last few weeks, although, in spite of the favorable conditions, the crop was late in maturing. The excessive rainfalls of 1915 and 1916 have, in all probability, been an important factor also in intensifying the effects produced on the crop by the various forms of soil "sickness."

To illustrate: It was observed that on fields known to be badly infested with the root-rot fungus (*Thielavia basicola* Zopf.) the percentage of plants infected sufficiently to check growth was much greater than usual in 1915 and 1916. The apparent leaching out of certain plant foods, especially the more soluble forms of nitrogen, was also observable, as indicated by the character of growth on some fields. Mention will be made of a few interesting observations on this point later in the report.

The theoretical benefit which might be derived from the leaching out of the accumulation of soluble salines — which Haskins[1] found to be excessive (as compared with soils producing normal crops) in certain spots and fields producing unthrifty plants — was apparently observable in some cases and not in others. It is unfortunate that determinations of the change in amounts of these salines present in soils which had been previously examined were not made, but lack of time prevented this.

It is a well-recognized fact that rainfall, soil-moisture, and temperature all play an important rôle in the making of quality of tobacco, and it is also true that, as a rule, the finest quality of cigar leaf is raised on light soils which carry relatively only a small percentage of moisture, say from 7 to 15 per cent. Aside from quality alone, in seasons with excessive rains there is always a falling off in the crop, particularly as regards weight.

A study of the rainfall, relative humidity, hours of sunshine, and temperatures during the main growing season as compared with the weight of the crop has therefore been made. The data as to average yield and yearly production in Massachusetts were obtained from the various Year Books of the Department of Agriculture. These figures are the only ones available, and it is believed by the writer that in most instances, at least, they are reliable. The meteorological data are taken from the records of the Massachusetts Agricultural College observatory, and are fairly representative of conditions in this section of the valley. The observatory is located within two or three miles of the center of the Massachusetts tobacco area around Hatfield. Of course, observations taken only a few miles distant would differ somewhat, but only in minor details, and it is believed that we are fully justified in using these observatory records. No data are available as to seasonal differences in water content of the different soil types in the tobacco region in Massachusetts. The quality of the crop in the different years was also difficult to ascertain, as here it was necessary to depend largely on the grower's or packer's memory for data, and they often were unable to recollect a crop for a given year with sufficient accuracy to make a comparison reliable. Therefore quality has not been plotted.

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[1] Haskins, H. D. Twenty-fourth annual report, Mass. Agr. Exp. Sta. (January, 1912), p. 35.

The average yearly yield per acre in Massachusetts is given in Table I for the period from 1901 to 1918, inclusive, together with the average yield from 1870 to 1910.

TABLE I. — *Average Yield of Tobacco per Acre in Massachusetts, 1901–18.*

YEAR.	Yield (Pounds).	YEAR.	Yield (Pounds).
1901,	1,810	1911,	1,650
1902,	1,560	1912,	1,700
1903,	1,400	1913,	1,550
1904,	1,690	1914,	1,750
1905,	1,850	1915,	1,100
1906,	1,750	1916,	1,600[1]
1907,	1,525		1,400[2]
1908,	1,650	1917,	1,430
1909,	1,600	1918,	1,520
1910,	1,730	Average yield, 1870 to 1910,	1,580

[1] United States.

[2] Massachusetts Agricultural College.

It will be seen that there is a marked variation in yield from year to year. The yield for 1916 as given by the United States Department of Agriculture (1,660 pounds) is much greater than the one estimated by the writer (1,400 pounds). This is probably due to the fact that the latter figures were obtained in part from the packing houses.

Fig. 1 is a graphic representation of the variation indicated by the above figures.

There was, unquestionably, a great reduction in yield in 1915, 1916, and 1917. *Can we look to a specific soil trouble, pathogen, or method of culture to account for this sudden and marked* GENERAL *decrease in yield?* It is hardly conceivable. A careful study of the yield in comparison with the meteorological conditions, however, does furnish us with important data, at least partially explanatory of the same. A study of Plates I and II (A and B), it is believed, will convince the most skeptical that the weather conditions during any given growing season determine to a great extent the yield, and that the *general* reduction in 1915 and 1916, as well as in other bad years, must be primarily attributed to these factors.

In these plates the normal for this locality is represented as the straight horizontal line or mean, and designated as (0). The variations of any given period — in this case, monthly — above or below normal are represented in black by the difference between the normal and that of any given month. Variations above normal are represented above the line, and below normal, below the line. Sunshine variation is given in hours, temperature variation in degrees Fahrenheit (F°), relative humidity in percentage, rainfall in inches, and yield in pounds per acre. Each season is divided into three parts, corresponding to the three principal months during which maximum growth occurs, — June, July, and August.

Studying these tables it is found that there is a rather close correlation between the various factors and the yield. Rainfall is, in Massachusetts, probably the most important factor bearing on the yield, followed closely by temperature and sunshine. The relative humidity apparently is not of such importance, so far as the actual yield is concerned. Calling attention to only a few of the more important differences will suffice.

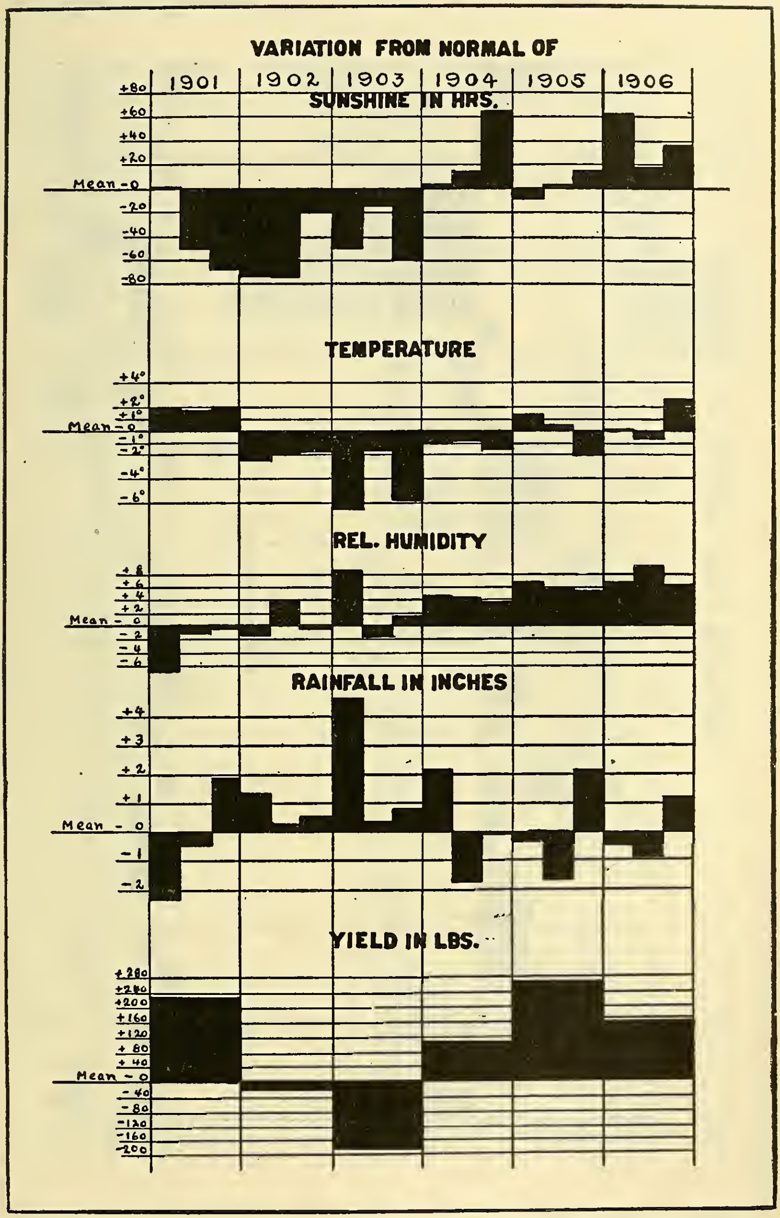
1915. — Sunshine slightly above normal in June, much below normal in July and August; temperature, 1.5–2.0° below normal for the entire growing season; relative humidity above normal except in June; rainfall practically normal in June, but from 4 to 5 inches in excess of normal during July and August; yield, 480 pounds below normal!

1916. — Here we have the reversal of conditions before mentioned: sunshine much below normal in June and July, above normal in August; temperature below normal for June, but above in July and August; rainfall excessive except in August, when it was 2 inches less than normal; yield better than in 1915, but still 180 pounds below normal.

1917. — Here we have a partial return to more normal conditions, but still somewhat abnormal; yield, 50+ pounds below normal for stalk tobacco.

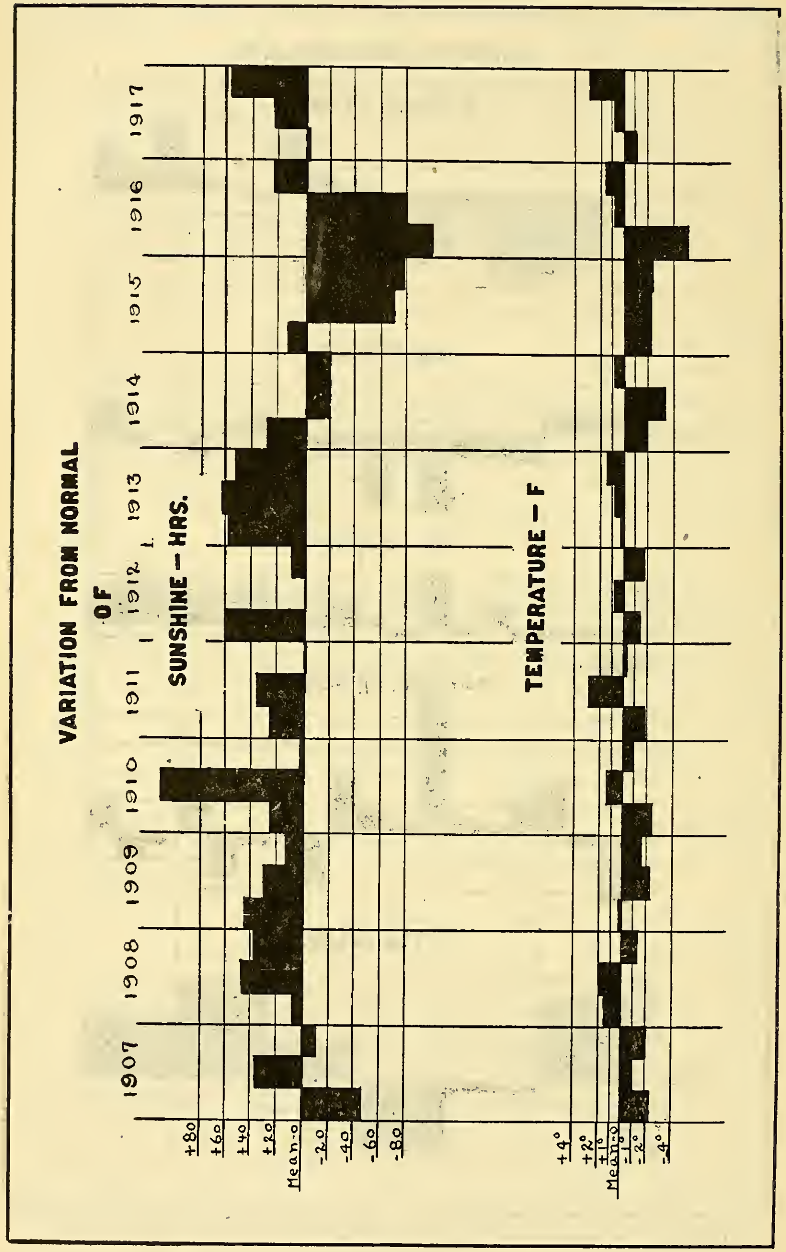
Going back still further it is possible to find analogous conditions in other years. It is safe to conclude that if there is excessive rainfall during the growing season, combined with low average temperature during the first half of the growing season particularly, the yield per acre will be small.

PLATE I.



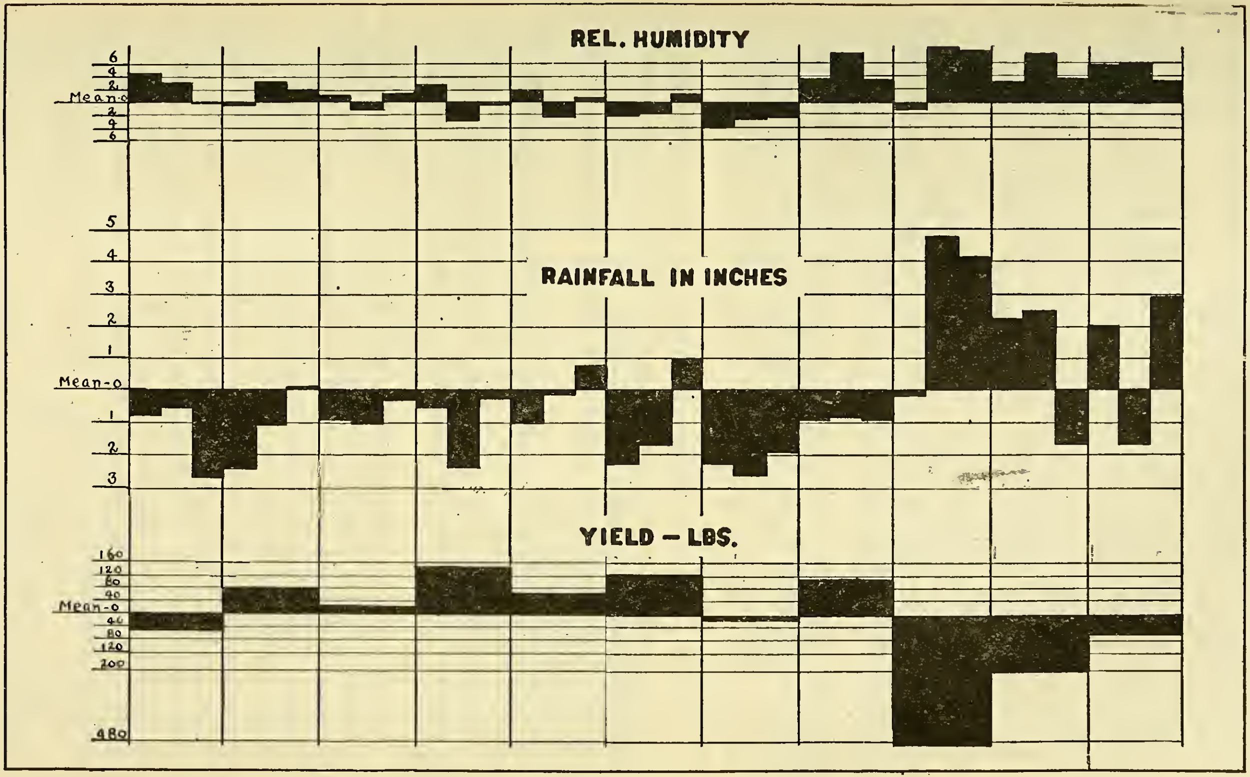
Variation from normal of sunshine, temperature, relative humidity, rainfall and yield, 1901–06, inclusive.

PLATE II A.



Variation from normal of sunshine and temperature, 1907–17, inclusive.

PLATE II B.



Variation from normal of relative humidity, rainfall and yield, 1907–17.

Excessive drought, combined with low or high temperatures, will also reduce the yield, but not usually to so great an extent as in the case of excessive rainfall. Good examples of the effects of drought on yield are to be found in 1907, and to a lesser extent in 1913.

Subnormal rainfall with subnormal temperatures does not reduce the yield to any great extent, providing they are not excessive (see 1909, 1910, 1912). The quality of the leaf is apt to suffer somewhat, however, in such cases.

A careful examination of the data leads us to the conclusion that for the development of our best crops we must have a season with normal or slightly subnormal rainfall, fairly well distributed, together with practically normal or supernormal temperatures.

Another factor of great importance is the distribution of the rainfall. For the best results the rainfall should be more or less evenly distributed over the growing period, not all in any one month or on a very few days of the month. The season of 1917 shows very well the effects of an unequal distribution of rainfall which, while averaging little above normal, reduced the yield. Here a very wet June, followed by a very dry July, brought the crop along to the danger point, and then the excessive rainfall of August, while helping growth, did not permit of a normal maturity, and as a result we get a subnormal yield.

As a result of the examination of these plates we may state that, in general, *rainfall is the major limiting factor of growth* (*and this necessarily includes soil moisture*), *together with temperature.*

Excessive seasonal rainfall is invariably followed by a reduction in yield independent of temperature.

Subnormal rainfall, when accompanied by temperatures excessively above normal, reduces the yield.

Subnormal rainfall, when accompanied by subnormal temperatures, does not apparently reduce the yield to any extent unless the rainfall is very much below normal.

In other words, there are apparently certain well-defined limits between which we may expect to get a normal yield, or better. A total rainfall for the season of from 6½ to 12 inches, if fairly well distributed, will give a good crop. Less than this or greater will give a yield below normal.

These conclusions are *general* and *seasonal*, and do not take into consideration other factors, such as *effect of precipitation* on soil temperature, fertilizer applied, parasitism of disease-producing organisms, type of soil, and method of culture. All these factors do play a more or less important rôle concurrently, but fundamentally rainfall and temperature are to be considered the limiting factors in production. The other factors mentioned are decidedly more local in their action, and are often possible of correction. They are what might be termed "individualistic," while the others are "communistic."

The effects, in any one season, of the rainfall and temperature as related to growth also make a very interesting study, and any one interested would do well to read Bulletin No. 39 of the Bureau of Soils, United States Department of Agriculture, in which is reported a season's study of these factors at Tarriffville, Conn. It would be out of place to detail them here.

In conclusion, it might be well to emphasize again that the *general* reduction of crop yield per acre is invariably associated with the seasonal rainfall and temperature, and not to any "running out" of the land (which was amply shown by the fact that the 1918 crop, according to returns, was much improved over those of 1915 and 1916, and was practically normal in spite of the July drought), due, primarily, to a specific widespread soil trouble.

This conclusion does not in the least minimize the fact that in many localities there is undoubtedly trouble due to improper fertilization, methods of culture, and disease-producing organisms; but these are *specific* problems, and not susceptible to *general* analytical consideration except in the group to which they belong.

They *may* assume major importance in seasons presenting abnormal meteorological conditions, and in such seasons are often held responsible for all reductions in yield. This should not be done, however.

Soil Relations.

During the season of 1916 many fields were observed where the unfavorable condition of the crop could not be accounted for by the presence of disease. On these fields the leaf was apparently normal in size or, in some areas, small and undeveloped; but it was thin and papery, and did not show the weight and quality of normal leaf grown on the same type of soil. In these cases not attributable to parasitic organisms we must look to an unbalanced physiological relationship between the plant and the soil, and this, naturally, first involves a study of the soil composition, reaction, and methods of fertilization.

Many theories have been advanced to explain this particular type of non-productiveness of tobacco soils, such as overfertilization, under fertilization, excess of soluble salines, toxic substances formed in the soil by the interaction of certain fertilizing constituents, injurious fertilizer constituents, the accumulation in the soil of toxic excretions from the roots of the tobacco plant, lack of potash, and a variety of other causes any one or more of which may possibly, under certain conditions, furnish the correct explanation. In general, however, it has been found difficult to ascribe the condition of the crop on such fields to any one factor with any degree of certainty, and it would appear that careful investigation is necessary to clear up some of these questions. In all probability no single factor is responsible.

It has generally been supposed that tobacco thrives best on a soil approaching neutrality, but our observations lead us to believe that this may not be entirely true, and that, possibly, some of our soils are too nearly neutral for the best development of tobacco. This seems to be particularly true where large quantities of lime have been applied to soils. The "good" tobacco soils examined showed a comparatively high "lime requirement," as determined by the Jones' method, using Haskins' factor for Massachusetts soils (4.46 instead of 1.8).

By the term "lime requirement," as used in this connection, is meant the amount of lime in the form of calcium oxide, CaO, it would be necessary to add to the soil to exactly neutralize it, *i.e.*, make it neither acid nor alkaline. It is not implied that the amounts of lime indicated in any given instance would benefit the tobacco crop.

The writer believes that, as a measure of the actual "lime requirement" or acidity of soils, none of the present methods of determination are satisfactory, and do not, in many cases, even approximate the true value sought; but when used as a comparative indicator for laboratory purposes in the examination of a series of soils they may be applied with advantage. In Table II will be found the "lime requirement" of some typical fields examined, together with comments on the crop, type of soil, etc.

TABLE II. — *Classification of Certain Soils according to "Lime Requirement," together with Data on Crop Condition, etc.*[1]

Group I.

SAMPLE No.	Acidity indicated by CaO Requirement (Pounds).	Crop Condition.	Root-rot Infection.	Years in Tobacco.	Limed.
07	1,200	Very poor,	No,[2]	–	Yes.
03	2,700	Very poor,	No,	–	Heavily.
8	3,000	Poor,	Light,	–	Yes.

Group II.

12	4,500	Poor,	Light,	–	Yes.
16	4,500	Poor; fair,	Light,	–	Heavily.
18	6,000	Fair,	Light; medium,	–	Heavily.
2	6,500	Very poor,	Very heavy,	6	Yes.
6	6,500	Thin; large growth,	Heavy,	40	Occasionally.
4	7,000	Poor; patchy,	Very heavy,	30–40	Occasionally.
14	8,000	Fair,	Light,	–	Little.
22	8,000	Very good,	Trace,	–	No.

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[1] The data given in this table represent only a part of the total collected, but are typical of conditions in general.

[2] "No" indicates that no root-rot was found on roots of plants examined. It is entirely probable that a very extended examination might in all cases reveal a slight amount.

TABLE II. — *Classification of Certain Soils according to "Lime Requirements," together with Data on Crop Condition, etc.* — Concluded.

Group III.

SAMPLE No.	Acidity indicated by CaO Requirement (Pounds).	Crop Condition.	Root-rot Infection.	Years in Tobacco.	Limed.
20	8,800	Good, . . .	No, . . .	–	No.
011	8,900	Excellent, . .	Trace, . . .	–	– –
A21	9,400	Very good, . .	No, . . .	4	No.
24	9,900	Good, . . .	No, . . .	–	– –
30	10,500	Good, . . .	Trace, . . .	–	No.
26	13,500	Very good, . .	No, . . .	2	No.
V17	15,500	A virgin soil ready for tobacco.			

The results are significant, and indicate that tobacco is making a better growth on soils which, with our method of acidity measurement, would be classed as rather acid. Until further investigation is made it would be unwise to emphasize this point unduly. Apropos of this, the general observations of Beals[1] on limed and unlimed areas substantiate, in a measure, these experimental findings. He found that out of 58 growers who made reports 43 had used lime more or less continuously, and most of these reported soil "sickness," while among those not using lime, only one case of soil "sickness" was reported.

A Study of the Reaction of Normal and "Sick" Soils as indicated by the "Lime Requirement."

In the past three years over 300 determinations of the so-called "lime requirement" of soils of all types used for tobacco have been made, as well as some of virgin soil broken for the first time for tobacco. The samples collected in different years were taken at approximately the same week or month, as the case might be, and as nearly as possible under similar conditions. In Table III there are arranged in groups the values obtained, together with brief notes on the condition of the crop during the season in which the samples were taken. It has not been attempted to include in this table, individually, all the soils examined, as this would be too cumbersome. The theoretical "lime requirement" is given in terms of CaO, and not as limestone or other commercial forms of lime.

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[1] Beals, C. In report of thirty-third annual meeting of New England Tobacco Growers' Association. Feb. 16, 1916, p. 25.

TABLE III. — *Tobacco Soils arranged in Groups according to "Lime Requirement," with General Notes on Crop Condition.*

	Number of Soils examined falling in Group.	Condition of Crop.	Root Diseases Present.
Group I: — 0-3,000 pounds CaO requirement.	21	Poor; fair, . . .	None-slight.
Group II: — 3,000-8,000 pounds CaO requirement.	137	Poor; excellent (better as the higher limit is approached).	None-very heavy (usually present).
Group III: — 8,000-15,000 pounds CaO requirement.	29	Good; excellent, . .	None-slight (unusual).

The results given in this table apparently indicate that tobacco is making a better growth on soils which are rather more "acid" than we have been in the habit of believing to be best for tobacco. As a matter of fact, the soils which show the least acidity are those which have had in the past large and more or less consistent applications of lime, or those which have been planted to tobacco for a long period of time. Whether or not these soils which seem to be so "acid" actually are, is an open question. In all the methods of acidity determination used, we measure the amount of acidity and not the intensity, and it is being found that a determination of the concentration of the hydrogen ion gives us, often, different results.[1] These results are important, and bring before us the question of lime (for we reduce the acidity of our soils by liming or by certain systems of fertilization) and its use on tobacco soils. Do they indicate that we have been liming too much, and that if we keep off lime entirely for a time we will eradicate much of the trouble? This cannot be stated absolutely as a general proposition in the light of work carried on so far, but it can be positively stated that we have found many instances where lime, especially in active form, has been applied to soils with the result that in from two to three years the crop has been reduced considerably. This is particularly noticeable where lime has been dumped and then later spread. The areas on which the lime was dumped became very unproductive, and we are therefore justified in stating that it would be advisable to withhold lime from fields which have been in tobacco for some time, especially from lighter soils where the supply of organic matter is small. Apropos of the advisability of adding lime to tobacco soils, especially light soils, it should be noted that some of the fertilizers used are alkaline, and that most of the brands contain in the neighborhood of 200 pounds of some form of lime added for various purposes.

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[1] A study of the hydrogen ion concentration in our tobacco soils is in progress and nearing completion. This study is to include a comparison of results obtained by this method with those of the present report, and a discussion of the practical interpretation of the same. This paper, which will of necessity be more or less technical in character, will be published separately.

The question as to whether the addition of large quantities of lime is necessary on our soils for the best development of tobacco — and its effect on the burn, ash, etc. — is still open to investigation. It depends to a certain extent on the type of soil. Recent investigations by the Dutch East Indies station have shown that the addition of lime had little effect on these factors. On the contrary, in some cases where the burn was injured there was a beneficial effect on the quality and color. Other experiments showed opposite results, and in general no particularly good effects were observed.

There is no question but what some lime is necessary for the best development of the tobacco plant, but a small application every few years seems to be preferable to a heavy application two or three years in succession. The mechanical composition of the particular soil to which the lime is to be applied should also be carefully considered.

There is another factor, connected with the liming of our fields, aside from that of the direct injurious effect of lime on the growth of tobacco as a result of the changing of soil reaction toward neutrality. Certain of our experiments have shown that the fungus *Thielavia basicola*, which causes root-rot, is very susceptible to acids, and we have found that it is very difficult for the fungus to thrive on very acid media. On the other hand, on media approaching neutrality the fungus develops rather better and makes a far more rapid growth. We are at present testing out in the laboratory different concentrations of acids and different acids, together with soil extracts, to determine if there is any difference in their reaction on the fungus.

These data regarding Thielavia root-rot substantiate the findings of Briggs,[1] who in 1908 reported results on the intensity of root-rot infection on tobacco in alkaline and acid soils, and who also recommended the stopping of lime applications on infected fields.

Referring again to the preceding table it might be stated that the roots of plants on the various soils which were analyzed were examined for Thielavia root-rot infection, and some interesting data were secured. It was found that in the soils of Group I, as it has been called for the sake of convenience, — that is, those soils which showed a "lime requirement" of from 0 to 3,000 pounds CaO requirement, — the crop was very poor; but there was little or no Thielavia root-rot evident. On the soils which I have designated as Group II, the crop was poor and patchy, or good, and on many plants the Thielavia root-rot was present in sufficient amount to cause a marked loss of root-feeding area. These soils all fell within a range of CaO requirement of from 3,000 pounds to 8,000 pounds. In Group III were placed all the soils showing a "lime requirement" above 8,000 pounds CaO, the crops of which were normal as far as growth was concerned, and many of them were very fine. In this group we find the acidity as measured in terms of the CaO requirement running as high as 13,500 pounds per acre. The highest value closely approaches the acidity of our virgin soils, such as are used when new tobacco plantations are established. Two of these virgin soils gave a "lime requirement" of over 15,000 pounds per acre.

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[1] Briggs, W. The Field Treatment of Tobacco Root-rot. U. S. D. A., B. P. I., Circ. No. 7, 1908.

From the preceding we can see that the situation with respect to liming is still further complicated. We have, on the one hand, the lime question and its effects on the growth of tobacco, pure and simple, and on the other, the effect of the soil reaction on the fungus which causes the Thielavia root-rot. If we lime continually and excessively land on which this root-rot is established, we are constantly getting it into a more nearly neutral condition, and hence into a more favorable condition for the development of the root-rot. In the end we will have a soil in which every year, irrespective of other factors favorable or unfavorable to the growth of the fungus, it will be able to develop vigorously and do great damage. In such cases soil reaction (changed by liming) should be looked upon as the primary cause of the trouble, and the presence of root-rot as secondary to this.

We find that this root-rot is not present to any great extent on soils showing a very low "lime requirement," which indicates that the soil is too alkaline for the development of the fungus, and also too alkaline for tobacco to make a satisfactory growth. At any rate, in this group (soils showing 0–3,000 pounds CaO requirement) the fungus is rarely found, though usually the crop of tobacco is very light and of poor quality. In the second group we find a large number of soils showing from 3,000–8,000 pounds CaO requirement, and it is to be observed that the Thielavia root-rot is present in a large number of fields. On these soils the crop varies from year to year, and in many cases is not of a satisfactory nature. On soils of this character in some years, however, good crops are produced, so we cannot here lay the damage to the lime alone, but must look to other additional factors.

In the third group we have soils which are acid and which show a high "lime requirement," — 8,000 pounds CaO and up, — but which are practically free from root-rot, and these soils are in practically all cases producing a good crop of tobacco. Does this not seem to indicate that the relationship between liming and Thielavia root-rot just discussed is a potent factor in many cases in the development of our troubles? There are, however, other factors to be taken into consideration, and in some cases these are of great importance also.

There is this fact patent, that on new land the tobacco always makes a good growth, although the quality of the leaf may not be all we desire. In these times, when the first consideration of the grower is apparently to get weight and let the quality come later, this is important, at least to the grower who has new land at his disposal. Most of the growers, however, have not new land that is suitable for tobacco, and cannot extend their activities in this manner, so of necessity they must confine their attention to keeping their tobacco fields in good tobacco condition by careful methods of fertilization.

Mere weight should not be the aim of the grower, as eventually this will lower the standard of Massachusetts tobacco. It is a well-recognized fact that heavy, rank tobacco is not, year in and year out, in demand by the manufacturers, and the aim should be to produce a fair weight of tobacco which has quality. A satisfactory price must be obtained for such a product, and it is due to the low price paid, more than to any other single factor, that the growers are striving to increase the weight of the crop. The cost of production is so great in Massachusetts that to secure adequate returns we must continue to grow a wrapper crop of good quality.

To return to the question of soil reaction and the practice of liming, it might be well to emphasize again the data collected by Mr. Beals of this station in 1914 (*loc. cit.*).

It is true that some growers have been using lime more or less continuously for some time, and are still producing excellent crops of tobacco, but this is the exception, and other factors — such as soil composition, organic matter supplied, etc. — are more or less responsible for the success of these men.

Humus or Organic Matter Content of Massachusetts Tobacco Soils.

The soils reported in Table II were analyzed for humus content by the method of the Association of Official Agricultural Chemists [1] as modified by Rather,[2] and a somewhat wide divergence in humus content was found, as might be expected. There were found some indications of a relationship between humus content and crop condition, as well as "lime requirement." Low humus content was more often associated with low acidity and poor crop condition. It may be safely stated that many of the soils producing poor crops are deficient in humus. Usually the presence of an optimum amount of humus or organic matter in a soil is considered an essential to crop production, but whether the quality of the leaf is injured or not by large amounts of humus in the case of tobacco is of importance. Growth and weight, without quality, are not to be desired. The question of the addition of humus to soils, found markedly deficient in this substance, is one which will bear investigation. Where it is found necessary to supply humus, we have the choice of crop rotation or cover-cropping and manuring, and, as most growers feel that they cannot practice extensive rotation with profit, cover-cropping and manuring would appear to be the only satisfactory solution of the matter so far as the question of humus is concerned. Whether, as some firmly believe, to restore the "sick" soils it will be necessary to rotate on a three or four year basis, is an open question, but one which should be seriously considered by those whose land is in very poor condition. It is to be hoped, however, that some treatment will be discovered which will render this unnecessary.

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[1] Official and Provisional Methods of Analysis. U. S. D. A., Bureau of Chemistry, Bulletin No. 107.

[2] Rather, J. B. Texas Bulletin No. 139. May, 1911, pp. 10–15.

Continued examination of normal and "sick" soils during 1917 and 1918 has served to substantiate the findings of the first year. Almost invariably there has been found to be a relationship between the organic matter content of a given soil and the development of the crop. This was especially true in the case of old fields which had been heavily limed, and fertilized for years with "chemical" fertilizers. These same fields, as a rule, had had no addition of organic matter, except such as came from the cottonseed applied, or from the stalks plowed under.

Our light and heavy soils, of course, vary widely in the content of organic matter when in a virgin condition, and, as a rule, the light types are the first to be depleted of their organic matter. These also are the soils which contain normally the smallest amounts of organic matter. Continued liming depletes the organic matter very quickly, and in this practice we have undoubtedly exceeded the limits to which we may go and maintain a favorable amount of humus in the soil.

Some of the soils show a very low humus content, — even less than half of 1 per cent, — and in some cases, even on the heavier types of soils, we found less than 2 per cent. The natural organic matter or humus content of our tobacco soils varies from about 1½ to 5 per cent or more, depending on the type of soil. It can be plainly seen that there is certainly a deficiency in many cases, and this should be remedied as soon as possible. Very few of the soils examined contained what would be considered the normal amount of humus for their type.

Organic matter is a very important factor in any soil, and particularly tobacco soils which are, in this section, cropped for years without any rest or rotation. Sufficient attention has not been paid to keeping up the supply of organic matter in the soils.

Organic matter affects the soil in many ways, both physically and chemically, and might almost be called a "soil regulator." Physically, it lightens heavier soils and binds lighter soils together and tends to make them loamy. It also increases the moisture-holding capacity enormously, and thus acts in a beneficial manner. Chemically, it adds to the plant food of the soil, as it contains the elements required by plants for food. Haskins' experiments at this station, in which he applied varying amounts of peat to some "sick" fields, showed very plainly that the peat exercised a beneficial effect on the growth of tobacco. These effects were due, probably, not only to the increase of organic matter in the soil, and the consequent action on the mechanical condition and water-holding capacity, etc., but also to the increase in soil acidity resulting from its application.

In our own experiments on "sick" soils — light and heavy — in the past two years we have shown conclusively that an application of even moderate amounts of organic matter increases the weight of the crop to a marked extent. In these experiments the organic matter was applied in the form of peat in varying amounts, from 2 to 4 tons, on a 12 per cent moisture basis. The following tabulation will show the increase in yield resulting from the addition of organic matter, all other factors in the fertilization being the same.

TABLE IV. — *Increase in Yield resulting from Application of Peat to Certain Soils.*[1]

PLOT NO.	Peat Application (Tons per Acre).	Average Yield of Peat Plots (Pounds per Acre).	Average Yield of No-peat Plots (Pounds per Acre).	Per Cent. Increase.
A, F, K,	–	–	1,330	10
B, G, X,	2	1,470	–	
26, 23,	1	1,400	–	–2
1, 4, 6,	–	–	1,420	–
R, O,	2	1,570	–	10

While these data have been obtained for only two years as yet, it is believed that they are sufficiently striking to warrant tentative conclusions being made, particularly as the check plots which contained no additional organic matter were subjected to the same conditions as regards planting, cultivating, etc.

Except in certain rare cases the application of organic matter in the form of peat would be out of the question on account of the excessive cost of the material and the labor involved in carting and spreading. *How can we add organic matter to our soils at a cost sufficiently low to be practicable?*

There are several ways in which this may be done. There is added to soil a considerable amount of organic matter from stalks, cottonseed meal, manure, etc., but naturally this is not sufficient to replace the losses. Heavy manuring will apparently be sufficient sometimes, but this is an expensive form in which to apply organic matter. We cannot afford to practice any extended system of rotation, but we can supply an enormous amount of organic matter by "cover-cropping" or planting a crop in the fall after the tobacco is taken off, and plowing it under in the spring before planting.

COVER CROPS.

Cover-cropping should be practiced wherever possible, not only as a means of adding organic matter to the soil but also to prevent washing and blowing, in the case of light soils.

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[1] The plots received uniform fertilization aside from peat. Manure plots, and peat and acid phosphate plots, gave still higher yields.

The choice of a cover crop depends on several factors, such as character of soil, presence of Thielavia root-rot in the field, etc. Some leguminous crop has often been advocated as a cover crop, but it is questionable if this is advisable for tobacco, as so many of the legumes (clovers, etc.) are also hosts of the Thielavia root-rot fungus, and would thus perpetuate it. *Any crop which will serve as a host for the root-rot fungus (Thielavia) should not be employed as a cover crop for tobacco.*

Rye, barley and timothy have been used in many instances with varying success, rye perhaps being most generally used up to the present time. There is one objection to rye, particularly on light lands; *i.e.*, if favorable growing weather prevails in the spring and any considerable amount of land is to be plowed, such a rapid growth of the rye top occurs that it is difficult to turn under thoroughly, and consequently it does not decay properly.

Barley is not generally used, and its use is not advocated.

Timothy has been used by some growers with good success, and from observation and trial on some soils the writer can recommend its use strongly, as it usually makes a good root growth, and does not grow so high as to be difficult of plowing under.

Although no positive data are at hand, it is believed that rye as usually planted will not furnish as much organic matter as timothy. Rye makes more top growth, but not nearly as much root growth as timothy.

According to our data, an ordinary cover crop of timothy will add to the soil over 2 tons of dry organic matter to the acre. Some figures of German investigators indicate even higher values, as much as 3 tons per acre.[1]

In addition to the direct benefit to the soil in organic matter, such a cover crop will aid in other ways. It will conserve nitrogen by preventing leaching, and will bind light soils, consequently preventing the blowing and washing which is so common in many fields.

The cost, per acre, for seed is very little, as the amount sown should usually be not over one-third bushel of good seed to the acre. The saving in nitrogen alone would more than repay the cost involved. The seed should be sown broadcast on stalk-cut fields, as soon as the tobacco is off, and on primed and shade-grown Cuban fields should be sown after the third picking at the latest.

Every tobacco field in Massachusetts should have a cover crop each year, and, so far as we can at present state, the choice should be timothy first, with rye second.

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[1] Subsequent to the preparation of this report the Connecticut station and Hartford County Farm Bureau published analyses showing that the average amount of dry organic matter returned to the soil by a timothy cover crop amounts to 3½ tons per acre. This would be, so far as organic matter content is concerned, the equivalent of 15 tons of manure.

Tobacco Diseases.

In the Seed Bed.

It may be stated on the authority of growers that while the weather conditions in 1916 were unfavorable to a rapid and uniform development of the seedlings, the beds were relatively free from parasitic diseases. Comparatively little damping-off of seedlings was reported, but the chief trouble seems to have been the checking of plants due to cool, moist weather conditions early in the season. After setting in the field, recovery was fairly rapid in most instances, and vigorous plants were produced. Judging from field examinations later in the season there probably was less "mosaic" in the seed beds than in some years past, as the number of mosaicked plants on a large number of fields observed was less than what is considered the normal infection.

The practice of sterilizing the seed beds by means of steam or formaldehyde — preferably the former for the sake of convenience — is on the increase, and with more attention being paid to such details as high pressure, complete sterilization of all soil in the beds, etc., more uniformly favorable results should be obtained.

It is believed, however, that the practice of sterilization of the same soil in seed beds year after year may not eventually produce the results desired, as we really know very little as yet about the action of steam on the soil, and its effects may prove detrimental if long continued. Thorough sterilization, when necessary, is recommended rather than indiscriminate, careless, or partial sterilization, which only adds to the expense of the crop.

As to the presence of the root-rot fungus (*Thielavia basicola* Zopf.) in the seed beds in 1916 no positive data are at hand, as our field work was started too late to allow of any examination of the plants in the seed beds. It is fallacious, in the case of root-rot, to draw conclusions from field observations as to its probable prevalence in the seed bed, owing to the fact that the causal fungus is apparently well established in many of our fields, and has been for some time. *It becomes generally of great importance, from an economic viewpoint, only in certain years when favorable environmental conditions for its development exist.* Thorough sterilization of the seed bed will also control this fungus when it occurs there. From data at hand it is believed that many seed beds, heretofore unsuspected, are infected to a certain degree with the root-rot fungus.

In the Field.

In order of importance and frequency of occurrence the diseases affecting tobacco in Massachusetts may be classified as follows: *Thielavia root-rot*, *"mosaic"* and allied diseases, *leaf spots* of various kinds, including *"rusts,"* *damping-off* in the seed bed, *stem-canker*, root-rots apparently induced by *Fusarium* or closely related forms, root-rots apparently induced by *Rhizoctonia* forms, *albinism* and similar chlorotic conditions, *sun-scald* of leaves, *bud-scald*, and *hollow-stalk* caused by injury and secondary invasions of organisms causing decay, and killing of plants by fertilizer applications.

Some few of these occur rarely and are of little importance, as, for instance, *hollow-stalk*, which has been observed only occasionally. *Bud-scald* was prevalent in the spring of 1919 in some fields which were planted during the extremely hot dry period in the latter part of June. The injury was not noticeable until the plants had been in the field ten days or more. The midribs of the bud-clasping leaflets were the parts most seriously affected, and, as a result of the killing of some of the cells on the underside of the midribs of the leaves which were closed over the bud, these failed to develop naturally, and the normal development of the leaf web and the upper side of the midrib caused the pair of leaves affected to bend sharply downward and grow very irregularly. Never more than one pair of leaves was found affected on any one plant. This injury, while sometimes resembling the type of injury caused by bud-worm, is quite distinct from it. *Sun-scald* of the leaves is, of course, something which cannot as a rule be prevented, and is usually noted on the leaves which have been turned over by the wind, exposing the under side to the hot sun. If water droplets collect on the leaves when in this position, and they are then exposed to the hot sun, there develops on the exposed areas a peculiar type of leaf spot due to burning, the water drops acting as lenses. *Fertilizer-burning* was noted in a few cases, but was usually found only in seed beds which had been treated with a large amount of quick-acting nitrogen to hasten their growth. Elsewhere in this report are noted observations on the overapplication of ground fish to tobacco beds. *Albinism*, a condition in which parts of the leaf are almost pure white while the rest of the leaf is normal green in color, has been noted rarely, and its occurrence is of little import. This condition may arise from a variety of causes, and has even been observed as a result of early frosts, but usually the plants outgrow the trouble and develop green coloring matter in the white areas.

There has been found a root-rot which is more or less similar in its effects to that caused by Thielavia, with the exception that there are no pronounced black lesions on the roots, but a more uniform browning and dirty discoloration, most of the injury being found on the fine, feeding rootlets, and not on the larger ones, as is often the case in a Thielavia infection. A form of Rhizoctonia has been isolated from diseased roots, but as yet it has not been possible to make satisfactory reinoculations with the cultures obtained. It would appear, so far as our observations go, that the fungus may be weakly parasitic in nature. There is a "damping-off" trouble, due to Rhizoctonia, which is found in the seed bed, but in this case infection is usually found near the surface of the ground, and often when such diseased plants are set in the field there results, under favorable conditions, the disease of the stem known as "stem-canker." The root-rot apparently due to Rhizoctonia is usually found in restricted localities in a field, and as yet is probably not of wide distribution. It remains to be proven whether the fungus is actually actively parasitic, or is capable of attacking only those plants which have become weakened by some other cause. As opportunity offers, work on this disease will be continued.

Root-rots, apparently induced by Fusaria or closely related forms of fungi, are seemingly on the increase, if we may take the isolation of these forms from diseased roots in almost pure culture as an indication of the causal agent. The roots of a large number of plants from patchy fields have been examined in the laboratory in the past two years, and in many cases forms of Fusarium, or closely related forms, have been isolated from the surface of the diseased roots. So far the few experiments in which it was attempted to infect the roots of healthy plants with pure culture material in the laboratory under control conditions have failed. It is a fact, however, that on many of the poorly developed plants in some fields we are consistently finding this fungus. A critical study of the question of Fusaria as the cause of a tobacco root-rot is being made by James Johnson of the Wisconsin station and the United States Department of Agriculture. In the writer's opinion, however, it may prove a difficult matter to establish the parasitism of this fungus, but it is to be hoped that something definite will result in the way of control measures. It should be noted that in fields where we have found the Fusarium associated with a root-rot of tobacco, there is a noticeable lack of infection due to Thielavia, the ordinary root-rot fungus of tobacco. This would indicate that the conditions necessary for the optimum parasitism of Fusarium are distinctly unfavorable to the development of the Thielavia. If this proves true, as these are both soil fungi, the question of control becomes rather perplexing. If it is shown that the Fusarium under certain conditions of soil reaction is actively parasitic, and these conditions are the ones that we have found to be practical for the control of Thielavia root-rot, the question of the finer adjustment of the soil reaction becomes an important factor, and more difficult of successful application.

Canker, noticeable in the field in 1916 as a decay and blackening of the stem at the ground, sometimes extending up the stem for some distance and occasionally girdling it, occurred only in isolated cases, and was of no importance economically. The direct causal organism, or organisms, is not well known, but the primary cause is probably due to a slight attack of damping-off in the seed bed, or even mechanical injury at the soil level, secondary organisms then gaining admission through the weakened tissue. So far the only field found to contain any considerable amount of canker is one to which very large amounts of manure were applied annually, the seed bed also being treated similarly. This excessive amount of organic matter furnishes a very favorable medium for the growth of bacteria and fungi, especially in the seed bed.

The leaf spots observed may be roughly divided into two classes, — those caused by organisms, and those with which no organism is associated. The second class is by far the more prevalent, and only in rare cases during 1916 were organisms found associated with a leaf spot. The amount of damage caused by leaf spots of this character is apparently slight, judging from the data at hand, but it is possible that more extended examination of fields may show different results.

The leaf spots not due to organisms were rather numerous in 1916, especially those classed as "rusts" by growers. One type of these "rusts" is usually found associated with the mosaic disease, and here the rusted spots which are made up of dead tissue are rather large and often coalescent, so that a comparatively large leaf area may be affected. Another type of "rust," believed by the writer to be associated also with the later stages of mosaic, was observed. In this case the spots were small, more regular in outline, not coalescent, and more thickly distributed over the leaf. There is some question, however, whether this type is always associated with the mosaic disease, as the same condition has been observed occasionally on plants not affected with this disease. In some shade-grown areas another type of spot or "rust" was observed, and it was not associated with mosaic. Here the spots were small, regular in outline, and widely scattered, some of the leaves showing only one or two such spots. It is not certainly known what the cause of this type of spot is, but it resembles a spot found in other tobacco sections where a lack of potash is said to exist. It may be due to other causes, however, and it is useless to even hazard an opinion on the question at this time. The whole matter of leaf spots requires investigation, particularly those spots which are not caused by organisms. It is expected that a study of these troubles will be taken up at a later date.

Mosaic disease was present in 1916 on many fields, but from an estimate of the amount on fifty-one areas it was apparently not present to so large an extent as in some years, approximately less than 3 per cent of the plants having the disease on commercial leaves. No account was taken of plants contracting the disease on the sucker growth appearing after topping, as it is believed that the presence of the disease on such growths does not affect the commercial leaves. The percentage of infection, in general, that season (1916) was below what may be considered the normal infection. (This count, however, included three very badly infected fields where a large percentage of the crop was affected, and this raised the percentage of infection considerably.) The prevalence of mosaic disease seems to be less than it was some years ago, and there has been only relatively small damage from this trouble in the tobacco section, as a whole, in the past two or three years. If more attention is paid to careful handling of plants in removal from the seed bed and during transplanting, the damage resulting from this disease can be reduced to an almost negligible amount. More attention should also be paid to fitting the land and keeping it in the best condition during the transplanting time and until the plant has obtained a good start. There is no question but that proper attention to such details and to the rejection of diseased plants in the seed bed will go far towards controlling the trouble, but it is improbable, owing to its nature, that it will ever be entirely eradicated. A good indication as to whether an infection is from the seed bed may be obtained by making a note of the time, after planting, of the first appearance of the disease in the field. If the disease is noticed at any time within a period of two weeks after setting, one may be sure that the infection came either from the seed bed or during the transplanting. If it appears after this length of time it is usually the resultant of a field infection. If all the leaves show the trouble it may also be stated that the infection came from the seed bed or from the conditions under which the plants were set. If it appears on some of the upper leaves at a later period the infection occurred in the field, and soil conditions should be looked into. A full discussion of the mosaic disease will be found in Bulletin No. 175[1] of this station, a copy of which will be mailed on request to the director's office.

Thielavia root-rot, or the ordinary root-rot of tobacco, is probably the most widespread trouble of fungous origin we have in our tobacco fields, and as a primary and secondary cause of many of our "sick" fields it is of great importance.

This disease appeared to be more destructive in 1916 than usual, although the amount could not be compared with that of 1915, as no extended examinations were made during that season. Many fields presenting an unthrifty appearance were studied with the idea of obtaining data as to the presence of root-rot, but in some cases only slight infections were found, the root systems of the plants not being parasitized sufficiently to account, in our opinion, for the general unthrifty appearance of the field. However, some cases were observed where the plants on entire fields were, to a large extent, badly infested with the root-rot fungus, and unquestionably these fields are in need of immediate treatment looking toward the eradication of this trouble. In nearly every case these heavy infections were on fields long used for growing tobacco, and the soil reaction and other factors were rather abnormal. It would appear from the observations made during the season of 1916 that in our fields the causal organism of Thielavia root-rot is widely distributed, but produces noticeable ill effects only when the soil and its environment are unfavorable to the best development of the tobacco plant and favorable to the rapid development of the root-rot fungus.

The control of this disease in the seed bed has already been discussed. There is no question but that it can be completely controlled by thorough sterilization either by steam or formaldehyde. The control of the disease in the field is an entirely different matter, however, and it is practically out of the question to attempt to eradicate it in the field by methods used for its eradication in the seed bed, because of their prohibitive cost. Even if the cost of material were considerably less than it is at present the labor and time factor would render such methods prohibitive. It is believed by some that a method of control by steam or formaldehyde can be devised, and that it will not be impossible of application from the economic point of view; but so far this has not been done. It may be possible to apply some compound in a dry state to the field, and to do it economically, but any application of a salt in solution would demand so much water to obtain the requisite penetration that it would be out of the question. So far a dry compound possessing the requisite fungicidal action has not been discovered. Certain solutions and salts have been used experimentally, but unfortunately none can be recommended for use on a commercial scale. A brief statement of the results obtained in our experiments with various compounds will be given below. It is believed that control can be better obtained by changing the soil reaction to a more acid condition by means of fertilization and cover-cropping, as has been indicated. The whole question of the prevalence of root-rot and its infection in our fields is closely bound up with the question of soil reaction, and it can hardly be profitably discussed apart from that problem. We have been able, by the use of cover crops and acid fertilizer materials, to "bring back" some heavily infested fields in a remarkably short time, and have no hesitation in recommending the use of a timothy cover crop and the non-application of lime to fields infected with the Thielavia root-rot. Of course there may be danger of getting our soils into a condition too acid for the best growth of tobacco, and judgment should be used in the application of any raw acid materials. The grower should not forget that "while a little may be a good thing, too much may be highly injurious." An increase in the amount of phosphoric acid, applied in the form of acid phosphate, has been found to have a beneficial effect, and apparently does not adversely effect the quality of the tobacco. In our experiments application of both "aged" and "raw" acid phosphate, in amounts of 400 and 600 pounds additional to the acre, has given uniformly good results, particularly on the lighter soils.

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[1] Chapman, G. H. Mosaic Disease of Tobacco. Mass. Agr. Exp. Sta. Bull. No. 175 (1917).

Thielavia Root-rot Investigations.

A statement of the results of some of our experiments having to do directly or indirectly with the Thielavia root-rot has been made in connection with other lines of work. Some of the experimental work, while interesting and fundamental from the scientific standpoint, can hardly be made use of at present as a basis for the treatment of infested fields. As a matter of record, however, a brief discussion of experiments is included in this report. The first work undertaken was the attempt to control the disease in the field by the application of chemicals to the soil. The data presented represent the work of two years. The plots were located on fields known to be heavily infested with Thielavia root-rot. The substances used were formaldehyde, copper sulfate, iron sulfate, mercuric chloride, potassium permanganate, sulfuric acid, sulfur, and "By-product A," a commercial preparation. With the exception of the sulfur and "By-product A" the substances were all applied in solution. All plots were in duplicate. The following table will indicate the amounts applied, calculated to an acre basis. A check plot (no treatment) was left between every two plots.

TABLE V. — *Chemicals applied, and Rates of Application.*

	POUNDS PER ACRE.		
Formaldehyde,	4,800	2,400	1,200
Copper sulfate,	400	200	100
Iron sulfate,	1,000	500	50
Mercuric chloride,	100	75	25
Potassium permanganate,	300	100	50
Sulfuric acid,	1,200	600	300
Sulfur,	2,000	1,500	1,000
"By-product A,"	4,000	2,000	1,000

The sulfur and "By-product A" were applied dry and thoroughly mixed with the 3 inches of top soil. The formaldehyde was so diluted that it was applied at the rate of one-half gallon of solution to the square foot of surface. On the first year's plots observations of a miscellaneous character were taken in addition to the root-rot data. The observations relating to growth are noted in the following table. They were made two weeks before harvesting. The growth data are calculated on the basis of the checks equalling 100, the plots being greater or less than this.

TABLE VI. — *Table showing Development of Tobacco in 1917 on Chemically Treated Plots.*

CHEMICAL.	Amount applied (Pounds per Acre).	Color.	Growth (Check=100; no Treatment).
Formaldehyde,	4,800	Normal,	100
	2,400	Normal,	125
	1,200	Normal,	125
Sufuric acid,	1,200	Normal,	125
	600	Normal,	100
	300	Normal,	100
Sulfur,	2,000	Light,	40
	1,500	Normal,	60
	1,000	Normal,	100
Mercuric chloride,	100	Normal,	45
	80	Very dark,	90
	25	Very dark,	100
Copper sulfate,	400	Normal,	100+
	200	Normal,	110
	100	Normal,	110
Ferrous sulfate,	1,000	Light,	94
	500	Normal,	87
	250	Normal,	100
Potassium permanganate,	300	Normal,	87
	100	Normal,	85
	50	Normal,	85
"By-product A,"	4,000	Normal,	94
	2,000	Normal,	94
	1,000	Normal,	100

It will be noted that the only substances which did not have an inhibiting action on the growth were formaldehyde, sulfuric acid, and copper sulfate. The rest of the chemicals applied did inhibit the growth of the tobacco, at least in the amounts applied.

A careful examination of the root systems of the plants in the different plots was made by Mr. Krout of this department, who was in direct charge of the root-rot work, and he reported as follows: —

TABLE VII. — *Comparison of Treatment with Thielavia Infection and Root Development.*

CHEMICAL.	Application (Pounds per Acre).	Thielavia Infection (Check Infection=100).	Root Development (Check=100).
Formaldehyde,	4,800 2,400 1,200	0+ 15 15	100 150 125
Sulfuric acid,	1,200 600 300	88 95 88	75 103 125
Sulfur,	2,000 1,500 1,000	80 70 80	38 65 90
Mercuric chloride,	100 80 25	83 83 88	78 88 90
Copper sulfate,	400 200 100	75 85 90	123 108 108
Ferrous sulfate,	1,000 500 250	90 90 100	70 95 115
Potassium permanganate,	300 100 50	90 60 95	100 100 100
"By-product A,"	4,000 2,000 1,000	100 88 90	93 105 95

From the above it may be seen that the only substance used which checked the development of the root-rot, or controlled it to any great extent, was the formaldehyde. The root growth also was apparently stimulated by the lower concentrations. Sulfur, mercuric chloride, and ferrous sulfate, while reducing the root-rot to some extent, had an injurious effect on root development. The copper sulfate and sulfuric acid reduced the amount of root-rot infection somewhat, and did not apparently, except in the case of the greatest strength of sulfuric acid, reduce the root development to any extent.

These experiments were continued in the following year with comparable results. It would seem that none of the substances used, with the exception of formaldehyde, were sufficiently beneficial in their action to warrant further experimental work at this time. The cost of this material and the labor involved, together with the large amount of water which is necessary, render it inadvisable to recommend this treatment on large areas. Small areas in a field might be so treated.

The sulfuric acid treatment did not give the results anticipated, but possibly a variation in amount applied might give more beneficial results. In this case, however, we should have to take into consideration the possible residual effect of the SO_4 radical (sulfate). Further data on this point will be available later. It would seem that, in view of the fact that Thielavia is so susceptible to acids, this might be a method of at least partial control.

The benefits to be derived from increasing the organic matter and general condition of the soil, in relation to the Thielavia root-rot, have already been briefly discussed, and further mention of them will be omitted.

Much laboratory work is in progress with the Thielavia fungus to determine the specific action of the different acids and bases on the growth and development of the fungus in culture, as well as to determine the limits between which the fungus is actively parasitic. The results, however, will not be discussed in this report, as additional work is necessary on this phase of the problem.

Fertilizer Experiments in Progress.

Beginning in 1917 there were established three experimental field plots on different soil types in the tobacco section. The yields on these fields were very low, so low on one of them that the crop had not been harvested. On one of the fields there was abundant evidence of a very serious Thielavia root-rot infection; on the other two, however, although the root-rot was present it did not appear to be of primary importance.

The experiments were designed to be general in character, and dealt with three principal questions, namely: (1) Are our soils in need of organic matter, and if so what is the response of the crop to the direct addition of the same in the form of peat, or in the form of stable manure? (2) Are our soils lacking in potash, owing to the inability of the growers to procure the usual amounts of the same since 1914, and if there is a lack how is it evidenced? (3) What benefits, if any, are to be derived from the addition of increased amounts of phosphoric acid in the form of acid phosphate to the normal fertilization? This question was suggested by the fact that very good results have been obtained in many cases by rotating tobacco and onions, and the latter crop is usually treated with a fertilizer containing a large amount of acid phosphate.

The results of 1919 are not at present ready for publication, but some rather definite results were obtained in 1917 and 1918. These will be briefly discussed here. The details of the experiments will not be taken up in this report, as the work is of sufficient volume to require a separate report, which is to be issued as soon as possible after the 1919 crop has been gone over and the results tabulated. Two of the plots were Havana and the third Cuban shade-grown. There has been a general similarity shown by the results on all of the plots.

In addition to the special treatments indicated below, it should be remembered that all the plots received an application of a 5–4–5 mixture, equivalent to an application of 3,000 pounds of commercial mixed goods of the same analysis per acre, except, of course, the no-potash plots. These received no potash in any form, except such as was in the manure or the cottonseed.

There was a marked increase in yield both in 1917 and 1918 on the plots which had received an application of organic matter in the form of peat at the rate of 2 tons to the acre (on a 12 per cent moisture basis), and also a slightly heavier yield with better quality on the manure plots than on the peat, the manure being applied at the rate of 10 tons to the acre. There was a still more marked increase in yield on the plots which had received organic matter, either as peat or manure, and acid phosphate at the rate of 300 to 600 pounds per acre. Where acid phosphate alone was used in conjunction with the regular fertilization without the addition of organic matter in some form the results even on the same plot were sometimes rather conflicting. It can only be stated that no uniformity of results was obtained. In some cases a marked benefit was noted as a result of the treatment; in others, on the same field, the results were apparently negative.

With respect to the lack of potash it was noticeable that there was no lack of this material indicated on any of the plots in 1917 and 1918. No differences were observed, so far as this material was concerned, between the plots which received applications of 350 pounds of high-grade sulfate of potash and those which received none at all. It should be stated, however, that the experimental plots were all located on land which had in the years prior to 1914 received liberal applications of potash, and it is quite probable that the supply of available potash in the soil was in no case exhausted. During the growing season of 1919 there were indications that on one of the fields there might be developing a lack of potash. The symptoms were not characteristic enough to warrant a positive statement on this point.

There is no evidence that our soils in general are suffering from a lack of potash, although a few local areas where this was the case have been brought to our attention during the past year. These cases were all on light soils and on soils which had not in the past received any heavy applications of potash in the fertilizer used. It would appear that new soils which have been used for a comparatively short period only before the shortage of potash are more liable to be suffering from a lack of potash than are some of the old fields which have for years received a very liberal application of this material. On these fields it is probable that there is an accumulation of potash in the soil sufficient to have carried the crop over the period of the shortage.

Organic matter, of course, can be economically applied to the soil in the form of a cover crop, as has already been mentioned, or as manure. This latter method is the more costly if all manure has to be bought, but some manure should be applied from time to time to get the best development of tobacco, apparently, although it is true that many growers are at present using commercial fertilizers and cover crops alone with good success.

The increased growth on acid phosphate in conjunction with applications of organic matter is conspicuous and rather difficult of explanation, aside from the points brought out in the discussion of the question of soil reaction. The tobacco plant uses very little of the available phosphoric acid of the soil, and certainly for direct fertilization effect, or as a food material, the plant needs only a small amount of the phosphoric acid available. It might be well to caution against the use of very large amounts of acid phosphate on our heavier soils year after year, as there is a tendency for this material to darken the leaf, and also, on account of the sulfate or sulfuric acid contained in it, to injure the burn. In our experiments, however, this has not occurred as yet.

MISCELLANEOUS OBSERVATIONS.

Other Root-rots.

While making an examination of the roots of plants from a field which had presented an unthrifty appearance all season (1916), but on which very little root-rot (Thielavia) could be found, it was observed that certain of the plants showed a peculiar discoloration of the root stock just below the surface of the ground. The only organism isolated was a species of Actinomyces, which was characterized by Dr. P. J. Anderson of this department as differing, apparently, from the ordinary forms found in our soils. No connection has been established as yet between the presence of this fungus in soils and its relation to the tobacco plant. No infection experiments have been made, but a study of this organism, if found again, is projected. Forms of Fusarium were also isolated from this and other material, but their rôle is problematic.

"Mammoth" Types of Cuban and Connecticut Havana Tobacco.

From time to time there have appeared in the fields of Connecticut so-called "mammoth" plants of Cuban and Connecticut Havana tobacco. Beinhart and Hayes first experimented with the mammoth Cuban type found in Connecticut on the plantation of the Windsor Tobacco Corporation by its manager, Mr. J. B. Stewart, from whom the type takes its name, "Stewart Cuban." This mammoth type was first grown commercially in 1914, and was found to cure in a very satisfactory manner.

At present the Stewart Cuban, or a very similar mutant, is being grown not only in Connecticut, but in Massachusetts as well to a limited extent.

It apparently is also satisfactory to the trade, which is essentially the final test of all tobacco.

In 1912 and subsequently, mammoth mutants have been quite frequently found in fields of Connecticut Havana. In 1916 our attention was called to two plants in a field in Sunderland by Mr. Frank Hubbard. These plants were darker green in color and had a larger leaf than did the average plant, and showed no indication of budding when the plants in the rest of the field were ready for topping. The number of leaves per plant was also greater, and they were set much closer together on the stalk. These two plants were removed to the greenhouse early in September and allowed to mature. It was not until mid-April of the following spring that the plants blossomed, and seed could not be obtained until May.

Before transplanting to the greenhouse there were primed from these two plants thirty-eight and forty-six leaves, respectively. It was reported that these leaves cured satisfactorily. At the time of blossoming there had been produced on the main stalk of each plant one hundred and thirty and one hundred and ten leaves of sufficient size to be called marketable.

In 1918 some few hundred plants were set in two fields, one in Southwick, on the farm of Mr. C. H. Granger, and one in Sunderland, on the land of Mr. Frank Hubbard.

The comments of the growers are as follows: Mr. Granger said, "I primed forty to fifty leaves from a plant, but they never cured right, and about the only recommendation I can give this tobacco is a fine-shaped leaf and increased weight. I topped some of it but got no better results."

Mr. Hubbard reported that he was much pleased with the type and habit of growth, but that as the plants were not set on what he would consider prime tobacco land he would prefer to try it again. Some of the tobacco he had bulk-sweated, and it came through rather better than was expected. The leaf had a good body, vein, etc., but contained little or no light wrapper, consisting principally of medium and dark wrapper and binder. The taste and burn were fairly satisfactory. The yield, in comparison with the ordinary type of Havana, was approximately doubled.

Further work with this type of tobacco, looking toward improvement of quality by varying the fertilization and also a method for maturing seed earlier, is in progress. It is believed that this mammoth type of Connecticut Havana may possess commercial possibilities.

High-pressure versus Low-pressure Seed Bed Sterilization.

It has been universally recommended that in sterilizing the seed beds with steam, as high a steam pressure as possible be maintained at the boiler, usually from 75 to 125 pounds, and that the steam be allowed to act under the pan for from twenty to thirty minutes in order to insure thorough sterilization.

Low-pressure outfits developing around 20 pounds pressure have been used, and in many instances with entirely negative results so far as killing disease-producing organisms was concerned.

It has been stated by some growers that they were absolutely sterilizing their beds with low-pressure steam in the same time as with the high-pressure outfits. There is no question but that certain types of soils will permit the use of low-pressure, providing the soil is in exactly the right mechanical condition and has a minimum water content. This has been done experimentally and practically on light porous soils, but unless the grower is assured by thermometer readings, or the complete cooking of potatoes at the desired depth, that the soil is sterile, it is apt to be a costly and futile undertaking.

It is much safer to use high-pressure outfits, particularly when the work is done by outside parties. In any event, the grower should assure himself that he is sterilizing the soil and not merely killing a few weed seeds. For general application the high-pressure method should be used; the low-pressure method will sterilize, but economically it has only a very limited range of application on certain soils. Usually there is too much guesswork in sterilization.

Vitality of Tobacco Seed.

It has been generally believed that the seed of tobacco retains its vitality for a number of years, even up to twenty. This may be true in exceptional cases in which the seed has been preserved under ideal conditions, but usually after the tenth year the vitality of our seed is so much reduced as to render it unfit for use, even when preserved under the best conditions.

A grower, however, often wishes to use a particular lot of seed a number of years, and it is of interest to know approximately, at least, what the germination of seed of the different varieties is at different ages. The maintenance of vitality, of course, depends to a great extent on the conditions under which the seed is kept, and this factor should be taken into consideration in drawing conclusions as to the germinability of the seed. In the following table are given some of the results obtained with seed of different ages kept under excellent conditions in a cool, dry place, either in muslin bags or wide-mouthed glass containers plugged with cotton: —

TABLE VIII. — *The Vitality of Tobacco Seed of Three Varieties preserved properly for Various Lengths of Time.*

VARIETY.	Age of Seed (Years).	Test No.	PER CENT OF GERMINATION AT TWO-DAY INTERVALS.						Average.
			2	4	6	8	10	12	
Broadleaf,	10	1	0	0	0	0	16	45	50
		1*a*	0	0	0	0	12	55	
	9	2	0	0	0	12	21	67	66
		2*a*	0	0	0	0	16	65	
	5	3	0	0	58	89	95	95	95.5
		3*a*	0	0	62	92	96	96	
	2	4	0	0	60	85	88	90	91.5
		4*a*	0	0	54	80	91	93	
Havana,	37	5	0	0	0	0	0	0	0
		5*a*	0	0	0	0	0	0	
	25	6	0	0	0	0	0	0	0
		6*a*	0	0	0	0	0	0	
	9	7	0	0	0	0	0	2	1.5
		7*a*	0	0	0	0	0	1	
	6	8	0	0	61	68	–	–	68
		8*a*	0	0	58	68	–	–	
	4	9	0	–	–	95	–	96	95.5
		9*a*	0	–	–	92	–	95	
	2	10	0	0	–	–	98	98	99
		10*a*	0	0	–	–	100	100	
Cuban,	6	11	0	0	8	22	41	54	49.5
		11*a*	0	0	18	35	41	45	
	4	12	0	0	23	74	88	–	82
		12*a*	0	0	31	66	84	–	
	2	13	0	0	27	86	91	–	93
		13*a*	0	0	28	90	95	–	

Considerable variation will be noted in the above table, and perhaps a larger series would have changed the results somewhat, but it was impossible to find seed saved under these conditions. The results at least serve as an indicator of the probable vitality of these varieties. The Broadleaf variety apparently retains its vitality longer than either the Havana or Cuban.

A few samples from tin cans and corked bottles were germinated at the same time with the following results: —

Five-year-old Broadleaf germinated only 31 per cent.
Three-year-old Broadleaf germinated only 72 per cent.
Two-year-old Havana germinated only 87 per cent.

Seed should be thoroughly dry when placed in containers, and some means of ventilation, or better, aëration, should be provided; otherwise the accumulation of moisture in the containers will be very conducive to mold growth. Seed preserved in cloth bags in a cool, dry place will retain its vitality longer, and give higher percentage of germination, than seed stored in air-tight containers.

Top-dressing Tobacco Seed Beds with Dry Ground Fish.

It is the custom of many growers to top-dress the tobacco seed beds occasionally with some quick nitrogen fertilizer, such as ammonium sulfate, nitrate of soda, commercial "starter," or fish. The danger of using an excess of the three former is pretty well recognized by the growers, but in the use of dry ground fish not so much attention has been paid to the amount used, as it has been claimed that it is impossible to apply an excess of this material.

This view is erroneous, as at least three cases have been noted where an excess has been applied, the "burning" of the plants taking place four to six days after application. In all cases the plants were thoroughly sprayed and the fish well washed off the leaves. Experimentally, the same applications proved injurious in all three cases. The mechanical condition of the fish seems to play a very important part in the injury, as in all three cases the fish was very finely ground, and in all probability the nitrogen was more quickly available than with other coarser or less nitrogenous fish.

No set rule as to the amount to be applied can be given, but as much discretion should be used with fish as with the ammonium sulfate or sodium nitrate, as the loss of the beds from top-dressing is a very serious matter. As a matter of fact, beds properly fertilized should not need any application of nitrogen except, perhaps, after they have been pulled over several times. While a large, apparently vigorous growth is obtained when the bed is repeatedly top-dressed with nitrogenous fertilizers, the plants are apt to be tender and succulent, and will not stand transplanting so well.

SUMMARY.

1. *The yield of tobacco in Massachusetts has not been gradually decreasing during the past ten years. Since 1914 the yield has been low, but this is due to adverse climatic conditions primarily.*
2. *In general, rainfall is the major limiting factor of growth (and this necessarily includes soil moisture along with it), together with temperature.*
3. *Excessive seasonal rainfall is invariably followed by a reduction in yield, independent of temperature.*
4. *Subnormal rainfall, when accompanied by temperatures excessively above normal, reduces the yield.*
5. *Subnormal rainfall, when accompanied by subnormal temperatures, does not apparently reduce the yield to any extent unless the rainfall is very much below normal.*
6. *There are, undoubtedly, in many localities specific problems to be worked on, such as the effects of improper fertilization, methods of culture, and control*

of disease-producing organisms; but these are "specific" and not "general" troubles as yet.

7. *The tobacco soils of Massachusetts fall into three groups, as regards acidity or "lime requirement." Soils with a "lime requirement" up to 3,000 pounds CaO per acre are not producing good crops, as a rule, and are comparatively free from root-rots. Those with a "lime requirement" of from 3,000 to 8,000 pounds CaO per acre are in good tobacco condition; but in this group pathogenic fungi are abundant in the soil, and the plants, during certain seasons, are very liable to suffer from root-rots caused by some of these fungi. Soils with a "lime requirement" of 8,000 pounds CaO up are usually comparatively free from such fungi, and even in unfavorable seasons little disease is found, but the tobacco is perhaps of slightly inferior quality.*

8. *Most of the tobacco soils in Massachusetts are deficient in humus or organic matter.*

9. *To supply this lack of organic matter cover crops, preferably timothy, should be planted and plowed under.*

10. *No satisfactory field soil treatment for the Thielavia root-rot has been worked out.*

11. *Many of the so-called "sick" soils are responding favorably to additional applications of organic matter and phosphoric acid in the form of acid phosphate. Care should be exercised in the application of these materials to guard against excess.*

12. *Our fields, generally, are not yet suffering from a lack of potash, as determined by plant growth and development.*

BULLETIN No. 196.

DEPARTMENT OF AGRICULTURE.

METHODS OF APPLYING MANURE.

BY WM. P. BROOKS.

INTRODUCTION.

The question as to the best system of handling and applying manures is one which has always excited a great deal of interest, and is of very special importance at this time. The reasons which have given the question exceptional importance in recent years are several. Among the more prominent are these: —

1. The increasing insistence, on the part of those using the product of our dairy stock, not only that manure shall not be stored, as was formerly the custom, in a cellar beneath the stable, but that it shall be promptly taken away from the vicinity of the stable.

2. The increasing cost of the labor of taking manure from the stable to the fields where it is to be used.

There are, of course, great possibilities of variation in methods adopted, but one of the most prominent in the minds of those making use of manure has been the question as to whether, when removed from stable or other place where it has accumulated, it is advisable to spread it at once upon the land, irrespective of the season of the year when it must be so removed, or whether provision should be made to store it in some manner and hold it until it can be incorporated with the soil. This has always been a question upon which there has been a great difference of opinion, both plans having earnest advocates, especially the plan of spreading manure as fast as it must be moved, on account of reduced cost of labor connected with its application under that system, and reduction of the pressure of farm work in the spring. The experiment described in the following pages was planned with a view to throwing light upon this question.

The experiment began in 1900. The land available for use in the experiment lay on a moderate slope from the east toward the west, which was fairly uniform, though not quite ideal in respect to uniformity, and which lay at an angle with horizontal of about 4½ degrees. The location is near the foot of the west side of a drumlin of moderate elevation. According to a soil survey made by the United States Department of Agriculture the soil is of that type for which the name Holyoke Stony Loam was suggested. It is a type of soil which with minor variations is very common throughout Massachusetts, and is known in the ordinary language of the farm as a moderately strong gravelly loam, with good capacity for retaining and conducting moisture, and somewhat affected, more or less unevenly as is pointed out in another connection, by seepage water which tends toward the surface from the higher portions of the drumlin as it finds its way downwards.

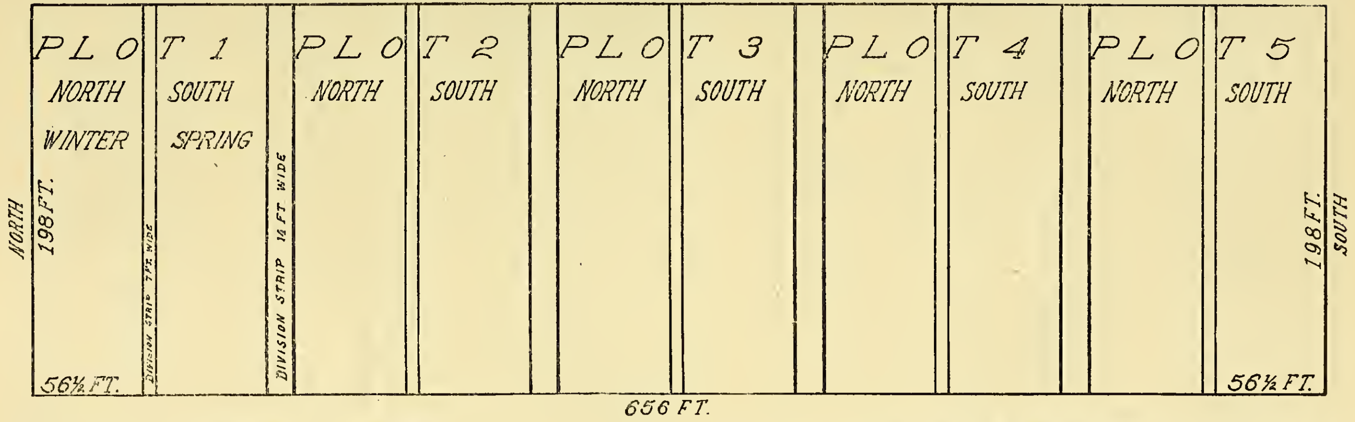
The land referred to had been used in an orchard experiment designed to test the relative results of different systems of manuring continuously followed from the year previous to the setting of the nursery stock. The kinds of fruit which had been used in the orchard experiment were peaches and pears. The land used was divided into five equal plots, each of which was uniformly manured annually from 1889 (the year previous to the setting of the trees) until 1897, both inclusive. As already indicated, the trees were set in 1890. The land proved unsuited to the peach and pear, a number of the trees died quite early in the experiment, and, since the number lost in different plots differed widely, it was decided to be inexpedient to continue the experiment with these kinds of fruit. Both manure and fertilizers used while the land was in fruit were applied broadcast in the early spring.

Plan of the Experiment.

The statements concerning the history of the area used in the experiment to be described have made it apparent that we had available five plots lying side by side upon a fairly even slope which had been respectively subjected to a widely varying fertilizer treatment. It is at once apparent that results on these plots could not be compared one with the other in such a way as to throw any light upon the question of the relative effects of different methods of applying manure. Accordingly each of the original orchard plots was divided in the middle by a line running directly up and down the slope. The different original plots were separated by unmanured or fertilized strips of land 14 feet wide, while the two halves of each of the original plots as laid out for the experiment under discussion were separated by a strip 7 feet in width. For purposes of record it was decided to retain the original orchard plot numbers, and to make the application of manure to the north half of each plot in winter, that to the south half in spring. The system followed to insure as closely as possible absolute equality in amount and kind of manure applied to north and south plots was as follows: —

All the manure used on plots 1 to 4, both north and south halves, was the product of the experiment station herd of milch cows. These cows were liberally bedded with baled planer shavings. The floor upon which the cows were kept was watertight, and the manure was removed at

PLAN OF PLOTS. MANURING EXPERIMENT.



Fertilizer Treatment, 1889–97.

Plot 1, manure, 10 tons per acre.
Plot 2, wood ashes, 1 ton per acre.
Plot 3, nothing.
Plot 4, ground bone, 600 pounds per acre; muriate of potash, 200 pounds per acre.
Plot 5, ground bone, 600 pounds per acre; low-grade sulfate of potash, 400 pounds per acre.

Manuring Experiment, 1900–19.

Manure applied annually, 1900–11 (with the exception of 1907), at the rate of 10 tons per acre.
North half, winter application.
South half, spring application.
Plots 1 to 4, cow manure; plot 5, horse manure.
Plot 1, early winter; plot 4, late winter.
No manure applied since 1911.

least twice daily to concrete pits, watertight and roofed. There were two pits. Manure was allowed to accumulate in the pits until the amount was sufficient to supply the needed quantity for an entire plot. The manure was then conveyed to the field, being weighed load by load as it was moved. (In referring to the different plots, the north half will be designated as "N," and the south half as "S." The arrangement and previous history will be understood by reference to the plan, page 41.)

The first load of manure was spread on plot N; the second load taken out was dumped into the foundation of a heap to be built out of the manure which was to be spread in the spring (this being located on some part of plot S, differing from year to year). Alternating loads were taken, respectively, to N and S, and either spread on N or added to the heap on S. The total weight when removed from the pits to the field as described was the same for both N and S. The annual application was at the rate of 20 tons per acre.[1] In building the heap on S, it was the practice to drive over what had previously been dumped as long as possible; and when all the manure had been taken out, the heap was squared up and was usually about 4 or 5 feet in height, with sides nearly perpendicular. In other words, the manure was so piled as to expose it as little as possible to danger of loss through washing and leaching. As has been indicated, care was taken in successive years to place the heap of manure on the different plots S on different parts of the plot, in order to equalize as far as possible any effect due to leaching of material directly from the heap into the soil beneath and in its immediate vicinity. Manure held in heaps from the time it was hauled out until spring was in all cases allowed to stand in the heap, when a hoed crop was to follow, until the soil could be worked. It was then spread on the plot on which the heap stood as evenly as possible, and then the entire area, including that to which manure had been applied during the winter, was disked, thus at once mixing the newly spread manure with the soil. When the land was in grass the time of handling the manure from the heap was practically the same as when the land was to be put into a hoed crop, and after spreading the manure from the heap upon the mowing it was the usual practice to go over the entire area, winter as well as spring applications, with a brush, for the purpose of fining and promoting a more even distribution of the manure. The manure held in heaps on all plots was almost invariably all spread in each year on the same day, or, if conditions rendered this impossible, the work once begun was completed at the earliest possible moment.

When the land was to be put into a hoed crop the following year, it was either sown to a cover crop of rye the previous fall or plowed late in the fall across the slope of the field. No attempt was made to vary the date of application according to variations in the field conditions as regards covering with ice or snow or freedom therefrom, and any one familiar with the New England climate will understand that there was very wide variation in conditions at the time of application. Plots N and S on plot 1 were the first plots supplied with manure except in 1911, when the order was reversed. With the exception of the year just named, plots 2, 3 and 4 were supplied in the order named. The application to plot 4 was therefore, with one exception, either very late in the winter or in the early spring.

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[1] A cord of undecomposed, well-saved cow manure from animals moderately bedded with planer shavings weighs about 3 tons.

TABLE I. — *Variations in Date of Application of Manure and of Spreading from Heaps.*

Plot.	North Half.		South Half.			
	spread.		piled.		spread.	
	Earliest.	Latest.	Earliest.	Latest.	Earliest.	Latest.
1,	Nov. 19	Mar. 13	Nov. 19	Mar. 13	Apr. 4	May 23
2,	Nov. 24	Feb. 26	Nov. 24	Feb. 26	Apr. 4	May 23
3,	Dec. 16	Mar. 31	Dec. 16	Mar. 31	Apr. 4	May 23
4,	Dec. 16	Mar. 28	Dec. 16	Mar. 28	Apr. 20	May 23
5,	Dec. 9	Mar. 8	Dec. 9	Mar. 8	Apr. 4	May 25

The manure applied to plot 5 was of different character. It was obtained from a local livery stable, and was horse manure usually comparatively fresh and containing a moderate amount of straw which had been used for litter. In supplying manure to N and S of plot 5, the plan described in outline for the other plots was followed; that is, alternate loads respectively spread on N and added to a heap on S, the total to N and S being the same for each.

In 1906 the whole field received an application of hydrated lime at the rate of 1 ton per acre. This was applied on the rough furrow and was worked in by the use of the disk harrow.

The experimental system of manuring described was continued annually from 1900 to 1911, both inclusive, with the exception of one year, 1907, when no manure was applied to any plot, and with a few minor variations which seem unimportant in their relation to the results obtained. In preparation for the experiment, the yield of all plots in the field under precisely similar manurial treatment for all was determined in 1899. In this year manure from the station herd of dairy cows was applied by means of the manure spreader driven transversely across all the plots in moderate and in precisely equal amounts to each, as nearly as careful regulation of the machine permitted. The field was planted with corn. There was considerable difference in the total yield of dry matter obtained on N and on S of plot 3, which reference to the plan (page 41) shows was the plot which during the continuance of the orchard experiment had been neither manured nor fertilized. These yields are shown in Table II, as also are the yields of dry matter in 1899 on all the other plots.

TABLE II. — *Dry Matter per Plot after Uniform Manuring in 1899. Ensilage Corn (Pounds per Plot).*

PLOT.	North Half.	South Half.
1,	1,559	1,660
2,	1,758	1,696
3,	756	1,271
4,	1,659	1,551
5,	1,616	1,703

It will be noted that there is but little variation in yield between N and S on the other different original plots, the extreme range being from 1,550 to 1,750 pounds. The results obtained, therefore, indicate that the conditions for the comparison of the two systems of applying manure were fairly satisfactory.

I would, however, call attention to the fact that probably more important than variations in fertility dependent upon differences in plant-food content were differences in moisture conditions on the different plots. The slope used in the experiment lay upon the west side of a drumlin, a geological formation extremely common and highly important in the agriculture of Massachusetts. As is likely to be the case with slopes on drumlins there is a tendency for seepage water, which sinks into the soil farther up on the slope or on the summit, to work outward toward the surface on the lower parts of the slope. During some years and with some crops this movement of soil water exerted comparatively little effect on the crop, but there can be no doubt that in seasons of comparatively heavy rainfall during the period of most active growth, especially of crops such as corn and soy beans which require high soil temperature for best results, it was sufficient on some of the plots to keep the soil cooler and wetter than is desirable for the best yields.

RELATIVE EFFECTS OF THE TWO SYSTEMS OF MANURING ON CROP YIELDS.

Table III shows the crops grown in successive years during the period of the experiment under consideration, and for each year indicates in how many of the five different comparisons either N or S, or one of them alone, gave the larger yields. Attention is called to the fact that the period during which manure was applied annually in accordance with the two plans under comparison was twelve years, and that there were five comparisons each year, or 60 in all.

TABLE III. — *Manuring Experiment, General Character of Results.*

Year.	CROP.	North Half ahead.	South Half ahead.
1900,	Corn (grain),	1	4
1901,	Millet,	–	5
1902,	Corn (ensilage),	2	3
1903,	Soy beans, beans,	3	2
1904,	Corn and soy beans (ensilage),	3	2
1905,	Corn (grain),	–	5
1906,	Corn (grain),	1	4
1907,	Mixed grass and clover,	2	3
1908,	Mixed grass and clover,	–	5
1909,	Mixed grass and clover,	3	2
1910,	Mixed grass and clover,	–	5
1911,	Mixed grass and clover,	4	1
	Totals,	19	41

Examination of this table shows that, as might be expected by any one familiar with the variations in our climate, results were not consistently favorable throughout the entire period, either to one or the other season of application; but the general average result was most favorable to winter application in 19 out of 60 comparisons, or practically 1 in 3.

The following points appear to be worthy of especial mention. In 1903, the crop being soy beans, the general average based upon results upon all the plots showed that plots N were ahead both in yields of beans and straw. In 1904, the crop being corn and soy beans which were ensiled, the crops were about equal. When the crop was mixed grass and clover the general average was favorable to the North half three years out of five, or in three-fifths of the trials. On the other hand, when corn for ripened grain was the crop, the South half was invariably ahead on the general average.

The general results, therefore, it may be said, appear to indicate that the common practice of top-dressing mowings with manure during the late fall or winter rather than in the spring is wise. If, however, we study Table IV, which shows the percentage results, it will be noticed that the average superiority of the North half is due to the fact that the first, or hay, crop is usually the better under that plan; the rowen crop, on the other hand, is usually better when the manure is spread in the spring, and the degree of superiority as indicated by the higher percentage shown in Table IV for the rowen crop under spring application is usually very high.

TABLE IV. — *Manuring Experiment, Percentage Results.*

Year.	Crop.		Percentage for South Half (North Half=100 Per Cent).				
			Plot 1.	Plot 2.	Plot 3.	Plot 4.	Plot 5.
1900	Corn,	Grain,	96.3	108.6	124.7	111.1	132.6
		Stover,	113.2	105.2	125.5	108.9	111.4
1901	Millet,		118.2	131.3	177.0	145.7	148.7
1902	Corn (ensilage),		103.9	97.3	150.0	91.6	108.6
1903	Soy beans,	Beans,	106.9	95.3	95.9	82.5	106.7
		Straw,	118.7	103.7	90.8	81.4	101.4
1904	Corn and soy beans,		92.2	107.4	130.1	92.9	97.2
1905	Corn,	Grain,	102.1	123.6	123.1	119.5	106.4
		Stover,	107.0	108.6	113.3	111.6	105.1
1906	Corn,	Grain,	105.9	122.9	108.4	93.2	102.2
		Stover,	105.9	114.0	107.9	99.1	100.2
1907[1]	Mixed grass and clover,	Hay,	100.3	98.7	107.0	92.9	95.2
		Rowen,	111.1	90.0	87.3	105.6	174.2
		Total,	101.6	97.3	103.5	94.5	101.6
1908	Mixed grass and clover,	Hay,	111.1	116.0	118.8	113.0	93.2
		Rowen,	113.1	115.7	111.8	86.7	143.8
		Total,	111.5	115.9	117.8	108.7	100.7
1909	Mixed grass and clover,	Hay,	81.4	99.4	105.6	86.1	92.0
		Rowen,	244.9	57.5	143.0	123.6	255.7
		Total,	85.7	95.1	107.3	88.7	102.1
1910	Mixed grass and clover,	Hay,	109.7	109.2	98.6	104.4	95.8
		Rowen,	188.9	90.6	131.6	141.0	168.1
		Total,	115.9	106.5	102.0	107.4	102.6
1911	Mixed grass and clover,	Hay,	107.6	101.2	94.6	96.3	104.2
		Rowen,	68.9	45.9	87.4	100.0	94.2
		Total,	100.0	94.1	94.2	96.4	101.5

[1] No manure was applied to either N or S on any of the plots in 1907, the reason being that the growth and general condition of the several plots which had been seeded in the corn in 1906 indicated a high degree of probability that should manure be applied the crop would lodge to a very serious extent. That the decision was wise was indicated by the results, for the crop even without top-dressing lodged considerably. The rate of yield on all plots was considerably in excess of 3 tons per acre for the first crop, and about one-half ton for the second crop on winter application, and considerably in excess of one-half ton where the manure in previous years had been applied in the spring.

Table V shows the rainfall in inches in each of the months of what may be called the growing season, together with the total for the several years. A study of the figures for the several months in the different years and the totals for these years has not sufficed to indicate any well-defined relation between rainfall and the relative standing of N and S. This, perhaps, is not surprising, because conditions affecting the amount of evaporation or loss of moisture from the land surface vary very widely in different years, especially important in this connection being the amount of sunshine, the mean temperature and the direction and amount of wind movement. The fact is we do not know them with sufficient accuracy to determine whether variations in local climate were sufficient to account for the differing results in the different years during which the experiment continued or to enable us to judge how important these climatic variations may have been.

TABLE V. — *Rainfall in Inches.*

YEAR.	April.	May.	June.	July.	August.	September.	Total for Year.
1899, ...	1.79	1.28	4.13	4.89	2.00	7.90	41.49
1900, ...	1.85	3.78	3.65	4.67	4.11	3.67	51.67
1901, ...	5.95	6.91	.87	3.86	6.14	4.17	49.72
1902, ...	3.31	2.32	4.54	4.66	4.65	5.83	46.99
1903, ...	2.30	.48	7.79	4.64	4.92	1.66	45.45
1904, ...	5.73	4.55	5.35	2.62	4.09	5.45	45.30
1905, ...	2.56	1.28	2.86	2.63	6.47	6.26	38.80
1906, ...	3.25	4.95	2.82	3.45	6.42	2.59	45.45
1907, ...	1.98	4.02	2.36	3.87	1.44	8.74	42.27
1908, ...	1.97	4.35	.76	3.28	4.27	1.73	30.68
1909, ...	5.53	3.36	2.24	2.24	3.79	4.99	39.12
1910, ...	3.07	2.67	2.65	1.90	4.03	2.86	36.11
1911, ...	1.87	1.37	2.02	4.21	5.92	3.41	44.21
1912, ...	3.92	4.34	.77	2.61	3.22	2.52	38.56
1913, ...	3.30	4.94	.90	1.59	2.26	2.56	39.50
1914, ...	6.59	3.56	2.32	3.53	5.11	.52	41.83
1915, ...	3.99	1.20	3.00	9.13	8.28	1.37	51.58
1916, ...	3.69	3.21	5.34	6.85	2.49	5.08	45.61
1917, ...	1.83	4.13	5.27	3.36	7.06	2.42	43.56
1918, ...	2.78	2.47	4.01	1.84	2.22	7.00	37.47
1919, ...	2.37	6.20	1.09	4.17	4.81	4.25	41.42

TABLE VI. — *Average Yields.*

CROP.	AVERAGE FOR FIVE PLOTS.		Per Cent for South Half (North Half = 100 Per Cent).
	North Half.	South Half.	
Millet (1 year),	3,847 pounds	5,414 pounds	140.7
Corn, ensilage (1 year),	15,890 pounds	16,914 pounds	106.4
Soy beans (1 year), Beans,	15.07 bushels	14.61 bushels	96.9
Soy beans (1 year), Straw,	1,212 pounds	1,193 pounds	98.4
Corn and soy beans (1 year),	22,034 pounds	21,907 pounds	99.4
Corn (3 years), Grain,	37.14 bushels	41.13 bushels	110.7
Corn (3 years), Stover,	4,452 pounds	4,844 pounds	108.8
Mixed grass and clover (5 years),	7,101 pounds	7,250 pounds	102.1
Total weight of crops removed, average of five plots.	100,517 pounds	105,694 pounds	105.2

Table VII indicates the number of times out of the twelve (the total number of years during the period when manure was generally applied annually) in which the yield on N was superior to that on S.

TABLE VII. — *General Results.*

PLOT.	North Half ahead —
1,	4 years out of 12
2,	5 years out of 12
3,	2 years out of 12
4,	7 years out of 12
5,	1 year out of 12

Examination of this table shows that on plot 3, S almost invariably gave the larger yield, N being superior to it only two years out of twelve. This may be explained by the greater fertility or better physical condition of S on plot 3, as shown by the yields given in Table II. On plot 5 the general superiority of S was still more marked, N giving the larger yield only one year out of twelve. It will be remembered that the manure applied to plot 5 was from horses, whereas that applied to all the other plots was from a herd of well-fed dairy cows. As has been pointed out, this stable manure was usually comparatively fresh, yet it had without doubt undergone more fermentation previous to being taken to the field than had the cow manure applied to the other plots. The effect of this greater progress toward complete disintegration at the time of spreading must have been to increase the proportion of soluble matter in the manure, especially the proportion of soluble ammonia and nitrates. It is a conclusion which these facts render extremely probable that the winter-spread manure on plot 5 suffered greater loss than that from cows spread on the other plots.

Further, it will be remembered that the length of time during which manure on plot 1 N was exposed was greater than on plots 2 and 4, and it is probably significant that S gave yields superior to N on plots 2 and 4 more frequently than on 1, a fact which this table brings out clearly.

Varying Effect of the Systems of Manuring on the Cover Crop of Rye.

No effort was made to determine the amount of green rye turned under on the different plots, but careful observations were made on the relative condition on N and S of the several plots. Our records of such observations show that, as would naturally be expected, the growth of the cover crop of rye during the early spring on plots N was superior to that on S. As is well understood, rye grows at an extremely low temperature, and wherever the manure had been spread during the winter the cover crop of rye derived considerable advantage from it. The dates of turning the cover crop under varied quite widely in successive years, being determined in part by peculiarities of season and in part by the crop which was to follow, but the plan adopted did not, as a rule, allow a very large growth, as it was always the aim, as it should be in turning under cover or green manure crops provided the bulk of green material is considerable, to turn the crop under some little time previous to the date of planting the crop which is to follow.

Conclusions apparently justified at the End of the Period of Annual Application.

My conclusions, if based solely upon results obtained during the period of annual application of manure, must have been about as follows: —

1. The various tabulations which have been presented indicate wide variations, and do not justify sweeping conclusions as to the superiority of either one or the other of the two systems under comparison.

2. The general results, however, in my opinion, indicate quite clearly that there was considerably more wastage, which varied from year to year in amount, from manure applied to plots N than from that first piled and later spread on plots S.

3. I believe that the fact of such excess wastage from plots N would have been brought out more distinctly by comparison of results had the rate of application of manure been lower, for the results afford fairly conclusive evidence that even after such wastage as occurred the amounts

of plant food remaining in the manure applied during the winter were in many cases at least sufficient to give the maximum yields possible under the other conditions affecting the crop.

4. I believe that our results indicate that conclusions based upon relative results of the two systems of applying manure compared for a single year or for a short series of years in current farm practice are in many cases unreliable because of the fact that the rate of application has often been sufficient so that even after such losses as occurred the supply of plant food was adequate for the crop under the conditions under which it was grown.

5. Whether the results of the comparisons made would have been similar on land more nearly level is a question on which I am able simply to express a general opinion. That opinion, based upon extensive opportunities for observation of conditions existing on Massachusetts farms, is that in almost all parts of the State there is sufficient slope to the land under cultivation so that some wash over the surface during winter and consequently some transfer of soluble plant food or absolute waste must usually be expected.

Relative Lasting Effects of Winter and Spring Applications.

Manure having been applied annually, with the exception noted, under the two systems compared from 1900 to 1911, inclusive, it was thought best to continue cropping the plots for a series of years without further differing application of either manure or fertilizer to plots N and S. As a matter of fact, the only applications made to any of the plots during the period 1912–19, both inclusive, were dressings of lime applied in 1914 and again in 1917 at the rate of 1,866 pounds per acre of calcium and magnesium oxides. Different forms of lime were used on each of the plots 1, 2, 3 and 5, namely, plot 1, hydrated lime, plot 2, marl, plot 3, fine-ground limestone, and plot 5, limoid. In each case both the form and quantity of lime applied to the two halves of the original plots (N and S) were precisely the same. It would therefore seem that the lime applied cannot have any immediate bearing upon the comparison of the lasting effects of the two systems of applying manure previously used.

The crops grown in the different years now to be considered, and the yields on the several plots, are shown in Table VIII.

It will be noted that the yields on plots S are in general considerably greater than on plots N. The percentage averages for the five plots in the different years, the yields on plots N being taken as 100, are shown in Table IX, also the relative percentage standing of N and S for the several plots.

TABLE VIII. — *Yields per Acre, 1912–1919.*

Year.	Crop.	Plot 1.		Plot 2.		Plot 3.		Plot 4.		Plot 5.	
		North.	South.	North.	South.	North.	South.	North.	South.	North.	South.
1912	Mixed grass and clover (pounds),	5,857	6,391	5,679	7,618	6,114	6,569	4,946	5,144	6,866	6,984
1913	Mixed grass and clover (pounds),	4,776	5,698	4,808	5,105	4,373	4,511	3,680	3,700	5,203	4,887
1914	Soy beans (ensilage) (pounds),	13,395	13,989	13,870	13,605	10,162	9,612	9,331	9,169	10,008	10,867
1915	Soy beans, Beans (bushels),	29.9	32.5	27.3	32.7	26.3	33.7	28.0	29.7	34.2	36.3
	Straw (pounds),	2,541	2,427	2,376	2,494	2,075	2,642	2,271	2,275	3,061	3,357
1916	Corn, Grain (bushels),	53.3	67.2	44.1	62.7	36.7	64.7	44.7	51.7	60.7	56.8
	Stover (pounds),	3,463	4,650	2,849	4,828	2,275	4,393	2,236	3,680	4,432	5,303
1917	Corn, Grain (bushels),	37.6	58.4	37.8	49.9	28.7	51.0	39.1	45.3	56.7	51.9
	Stover (pounds),	2,790	4,551	2,078	3,957	1,919	3,878	2,770	3,621	4,333	4,690
1918	Mixed grass and clover (pounds),	2,572	3,265	3,245	3,324	3,166	2,711	2,117	2,623	2,691	4,056
1919	Mixed grass and clover (pounds),	2,513	5,224	4,076	5,144	1,662	3,364	2,157	3,482	3,977	4,630

TABLE IX. — *Percentage Results.*

Year.	Crop.	Percentages for South Half (North Half = 100 Per Cent).					
		Plot 1.	Plot 2.	Plot 3.	Plot 4.	Plot 5.	Average of Five Plots.
1912	Mixed grass and clover,	109.2	134.1	107.4	104.0	101.7	111.0
1913	Mixed grass and clover,	119.3	106.2	103.2	100.6	93.9	104.6
1914	Soy beans (ensilage),	104.4	98.1	94.6	98.3	108.6	100.8
1915	Soy beans, Beans,	108.9	120.1	128.4	105.8	106.0	113.8
	Soy beans, Straw,	95.5	105.0	127.3	100.2	106.7	107.0
1916	Corn, Grain,	127.8	146.3	185.1	118.5	93.5	126.6
	Corn, Stover,	134.3	169.5	193.1	164.6	119.6	149.8
1917	Corn, Grain,	164.5	140.2	192.0	124.8	91.8	128.4
	Corn, Stover,	163.1	190.4	202.1	130.7	108.2	149.0
1918	Mixed grass and clover,	126.9	102.4	85.6	124.3	150.7	115.9
1919	Mixed grass and clover,	207.9	126.2	202.4	161.5	116.4	151.8

The general percentage average for plots 1, 2, 4 and 5 for the entire period 1912–19, inclusive, N being taken as 100, is 122.3 for S, while for plot 3 a similar comparison shows the standing of S to be 138.2.

The figures presented in the different tables bring out the fact very clearly that the lasting effect of manure piled when taken to the field and spread in the spring is much greater than that of manure spread in the winter. For confirmation of the fact just stated, the reader should compare the figures given in Table IX with those in Tables VI and VII, which refer to the period during which manure was applied annually.

The figures for successive years presented in Tables VIII and IX indicate clearly that the superiority of plots S as compared with plots N as yet shows no signs of diminution. On the contrary, it is considerably greater during the later years of the period under consideration than in the earlier. This is most clearly shown in the last column of Table IX, which gives the percentage averages of the five plots; thus, for example, during the first and second years of the period under consideration, plots S in mixed grass and clover showed a percentage superiority of 111.0 and 104.6; in the last two years, 1918 and 1919, corresponding figures were 115.9 and 151.8. A similar relation is shown between the percentage advantage of plots S in 1915 as compared with 1914, soy beans being the crop; and in 1917 as compared with 1916, corn being the crop. This advantage in the case of the corn crop is less than with the others.

Effect of the Two Systems previously followed in the Application of Manure on Growth during the Early Part of the Season and the Maturing of the Crop.

From the very first year of the period under consideration, 1912–19, it was noticed that much earlier and more vigorous growth took place on plots S than on plots N. Whatever the crop, the superiority of S was clearly shown by better color and more rapid advancement. It would have been a matter of great difficulty to determine the difference in amount of growth made at any given period by measurement, but the field was under constant careful observation, and my own judgment I feel sure is accurate. When corn was the crop, I should say that by the last of June or the first of July the average height of the plants on plots S was some 3 or 4 inches greater than on plots N. When the field was in mixed grass and clover, the degree of superiority was in my judgment about the same, and indicated in inches would, I think, equal about 3 inches by the first of June. The earlier maturity of the crops on plots S also clearly indicates an earlier start and more rapid progress. This is shown most conclusively by the figures in Table X, showing the relative proportions of hard and soft corn at the time of husking.

Table X. — *Effect on Ripening Corn* (*Pounds per Plot*).

Plot.	1916.				1917.			
	North Half.		South Half.		North Half.		South Half.	
	Hard.	Soft.	Hard.	Soft.	Hard.	Soft.	Hard.	Soft.
1,	915	29	1,170	19	700	60	1,150	30
2,	745	35½	1,090	19	700	64	980	29
3,	605	45	1,120	25	505	75	970	60
4,	755	35	895	20	710	80	885	30
5,	1,055	20	985	20	1,115	30	1,025	25

It will be noted that plot 5 is an exception to the general rule that the proportion of hard corn is considerably greater on plots S than on plots N. A considerable number of my different experiments, confirmed, I believe, as a rule, by the experiments of others, indicates that the period of ripening is affected more by the supply of phosphoric acid in highly available form than by any other plant-food constituent. An excessive supply of potash or of nitrogen does not, I believe, favor early ripening, but quite the contrary, unless there be a very liberal supply of phosphoric acid. It seems to me highly probable that the relative high standing of plot N on 5 in the proportion of hard corn is connected with the fact, which is generally known, that the proportion of phosphoric acid in manure from horses is higher, as a rule, than in that from milch cows, but I desire to point out that a little variation in level and character of soil from the north to south perhaps helps to account for the relatively high standing of N on plot 5.

We have yet, however, to consider how the superiority of S on the other plots, 1, 2, 3, and 4, can be accounted for. It seems to me possible that variation in humus content produced by the different methods of handling the manure and consequent differences in soil temperatures or in biological activities going on in the soil may to some extent have influenced the results. I believe, however, that more important than these is probably this fact, which, as was pointed out again and again by Paul Wagner in connection with his different experiments a considerable number of years ago, had an important connection with results.[1] Wagner pointed out that in northern latitudes optimum weather conditions for growth may exist during only a small proportion of the so-called growing season. This fact is generally recognized. All those familiar with agriculture in Massachusetts understand that, especially for crops flourishing at high temperatures and to a considerable extent for others also, weather conditions during some part of the growing season are unfavorable to rapid progress. It is often too wet or too dry, or it may be too cold, and rather exceptionally too hot when the high temperature is coincident with shortage in supply of moisture. When optimum weather conditions come, then the plant is capable of extremely rapid growth, provided the other factors essential for such growth exist, and among such other factors an abundant supply of plant food is one of the most important. Where the supply of plant food is comparatively low or meager the crop may become a good one if the weather and other conditions for growth are favorable throughout the greater part of the growing season, but, in proportion as the best of weather exists only a portion of the time, the crop will come to rapid maturity only where it finds a great abundance of food. Considerable wastage evidently occurred where the manure was spread in the winter. It is clear, therefore, that the supply of food, and hence this one among the several factors essential to rapid progress when the weather conditions are right was found in highest degree on plots S. It has long been recognized that the farmer or gardener who works his land intensively (under which term in this connection I refer particularly to an abundant supply of available plant food) is less unfavorably influenced by bad weather than the farmer or gardener whose soils are relatively low in available plant food or poorly worked.

THE RELATIVE EFFECTS OF THE TWO SYSTEMS ON THE PROPORTION OF CLOVER IN MIXED MOWINGS.

Whenever the plots used in this experiment were put into mowing, a mixture of timothy, red top and medium and alsike clovers was sown. The field was in mowing in 1912 and 1913, the first two years of the period under consideration, and it was noted that the proportion of

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[1] Paul Wagner: Zur Kali-Phosphat-Düngung nach Schultz-Lupitz, Darmstadt, 1889, s. 18 u. a.

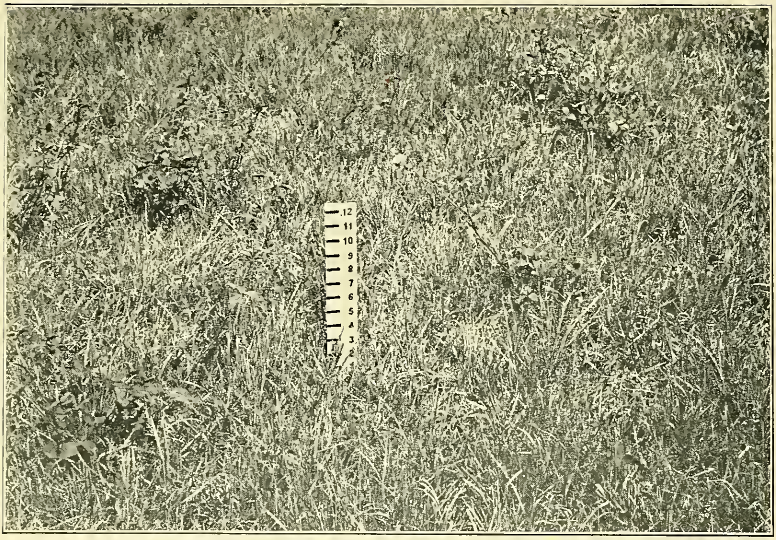

Fig. 1.—Plot 1, north half, from photograph taken Aug. 7, 1919.

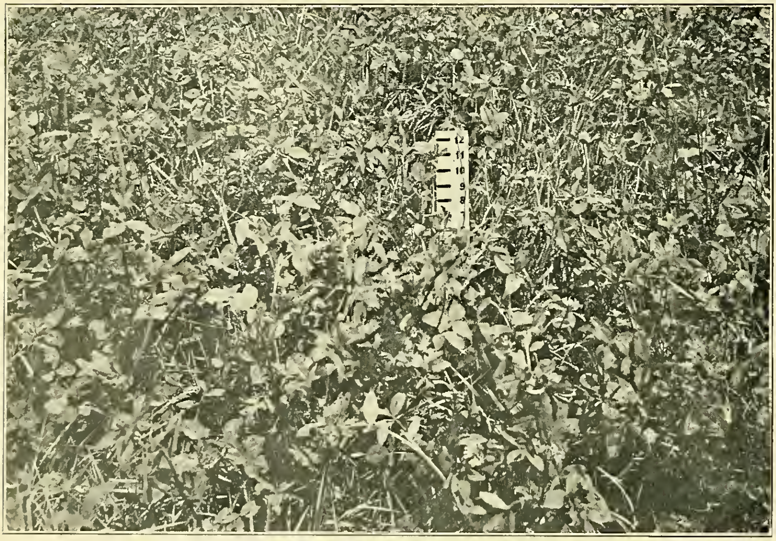

Fig. 2.—Plot 1, south half, from photograph taken Aug 7, 1919.

clovers on plots S was considerably greater than on plots N. The distribution of clovers in the different plots was not entirely uniform, some variations being apparently due to differences in moisture conditions. No photographs were taken during these two years, and the fact stated is demonstrated principally by the greater superiority of the rowen crop (made up chiefly of clovers) on plots S than of the first crop on the same plots.

The plots were put into mowing again in 1918, the seed having been sown, as is customary in this part of the State and with the type of soil on which the experiments were located, in the standing corn about the time it was waist high in 1917. We have harvested the hay crops now for two years, and Figs. 1 and 2 were made from photographs taken on Aug. 7, 1919, by a station assistant, R. L. Coffin. The difference in the proportion of clover, it will be seen at once, is very striking. The proportions of grasses and clovers on different parts of the several plots were not entirely uniform either on single plots N and S, under comparison, or on different pairs, and the excess of clover was not as great everywhere as indicated by the illustrations.

With a view to indicating in words as clearly as possible the different conditions, notes were taken on June 17, 1918, by a very careful station assistant, Mr. R. L. Coffin. I quote from Mr. Coffin: —

Plot 1. N, very little clover, mostly red.
S, seven-eighths clover, red and alsike about evenly divided.
Plot 2. N, seven-eighths clover, mostly alsike, but more red than on plot 5.
S, over seven-eighths clover, practically a dense mass of clover, more red than alsike.
Plot 3. N, almost no clover, but a little both red and alsike present.
S, nearly seven-eighths clover, more red than alsike.
Plot 4. N, about one-fourth clover, mostly alsike; a little sorrel.
S, nearly seven-eighths clover, mostly alsike; a little sorrel. Growth on plot 4 not as heavy as on plot 5.
Plot 5. N, seven-eighths clover, mostly alsike.
S, a little more clover than on N. Except for two small areas, a dense mass of clover, mostly alsike.
General condition on all plots: heads just beginning to show on timothy and red top, the proportion of red top being apparently somewhat greater than that of timothy.

WHY CLOVER HAS BEEN MORE ABUNDANT ON PLOTS S.

The facts which have been for a long time known concerning the proportions of the different leading plant-food constituents and their degree of solubility in manures appear to the writer to have indicated in advance the more important wastes likely to occur from manure spread during the winter and allowed to remain upon the surface. The more important of these facts which seem to have a bearing upon the results are as follows: —

In fresh, well-made cow manure the proportion of its nitrogen content soluble is about one-third of the whole; the proportion of its potash content soluble is about four-fifths of the whole; while practically all of the phosphoric acid is insoluble. In the case of the plots, then, to which cow manure was applied in winter, one must have anticipated that such waste as occurred would have carried off more potash than of either of the other more important elements. In the case of the stable manure applied to plot 5, as has already been pointed out, some fermentation had taken place before it was taken to the field. This must have increased the solubility of the nitrogen content, but this manure, it will be remembered, was from horses, and such manure is much drier than fresh cow manure, the urine being relatively far less abundant. This must, I think, decrease the probability of a loss of potash from manure spread during the winter. Moreover, the application made to plot 5 was usually comparatively late in the winter, so that the period of exposure on the surface was shorter than the average of the other plots, which also would tend to decrease the amount of such loss of potash as may have occurred.

It is now a matter of almost universal knowledge that the proportion of clover in mowings is much affected, throughout the greater part of the soils of Massachusetts at least, if not throughout those of the greater part of the northeastern section of the United States, by the supply of potash in available form; and the much greater proportion of clover on plots S than on plots N of 1, 2, 3 and 4 tends to confirm my opinion in a striking way, — that the greatest loss which occurred from manure spread upon the surface in the winter and allowed to remain there until spring was the loss of potash. The fact that there was less difference in the proportion of clover on N and S of plot 5 than on the other plots tends also to confirm the correctness of the opinion expressed concerning the losses from the partially fermented stable manure.

Just how great may have been the losses of nitrogen from manure spread in the winter and allowed to remain on the surface, our figures showing yields fail to give a very complete index; but the fact that in the eighth year without additional manure the yield of hay even on plots N was, in general, good shows that the wastage of nitrogen was probably not very excessive. Nor would excessive loss of this element, as a rule, be reasonably expected, in view of the fact that the manure spread in the winter on most of the plots was practically entirely unfermented, and could not under normal winter weather conditions undergo fermentation while lying upon the surface, which would increase the solubility of the nitrogen compounds found in the fresh manure.

Financial Results.

The basis of the calculations upon which the tables presenting relative financial results have been computed is as follows: Value of products per ton: millet hay, $10; mixed grass and clover hay, $12; rowen, $8; ensilage corn, $4; corn and soy bean mixture for ensilage, $4; soy beans for ensilage, $5; corn stover, $6; soy bean straw, $5. Value per bushel: corn, 70 cents (1 cent per pound on the ear); soy beans, $2.50. The calculation was made on the basis of the average for the five pairs of plots N and S, and the area for which results are computed is 1 acre. The excess cost of handling manure where it was piled when hauled out and spread in the spring has been estimated at $2 per acre where the work is done upon a large scale, for on such scale the manure spreader would be used in applying the manure from the heaps in the spring, whereas conditions when manure is hauled out and applied during the winter are by no means always such in our climate as to make the use of the manure spreader practicable. It is believed, therefore, that the figure taken — $2 per acre — is sufficient to represent the difference in cost under conditions existing on farms of sufficient size to justify the use of the spreader.

The same values have been used in the calculations throughout the entire period covered by the two tables, although prices during the past four or five years have advanced materially, so that the figures taken as applied to these years are considerably too low. The reader will perhaps at once think that so also must be the figure representing the difference in the cost of handling the manure; but in this connection it is important to remember that during the past eight years no manure has been applied to any of the plots, so that the question of the excess cost of handling does not affect the results as presented in Table XII.

TABLE XI. — *Calculated Results per Acre for the Period of Annual Application of Manure.*

CROP.	CROP VALUES, YEARLY AVERAGE. DIFFERENCE IN FAVOR OF —		COST OF APPLICATION OF MANURE. DIFFERENCE IN FAVOR OF —	TOTAL YEARLY AVERAGE. DIFFERENCE IN FAVOR OF —		Number of Years.	TOTAL DIFFERENCE IN FAVOR OF —	
	Winter (N).	Spring (S).	Winter (N).	Winter (N).	Spring (S).		Winter (N).	Spring (S).
Millet, ...	–	$7 83	$2 00	–	$5 83	1	–	$5 83
Soy beans, . . .	$1 20	–	2 00	$3 20	–	1	$3 20	–
Corn, ...	–	3 97	2 00	–	1 97	3	–	5 91
Mixed grass and clover,	–	66	2 00	1 34	–	5	4 70[1]	–
Corn (ensilage), . .	–	2 05	2 00	–	05	1	–	05
Corn and soy beans (ensilage).	25	–	2 00	2 25	–	1	2 25	–
Total, . . .	–	–	–	–	–	12	$10 15	$11 79

Balance in favor of spring, $1.64.
Average for 1 year, $0.14.

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[1] No manure applied in 1907; cost of applying deducted.

Examination of Table XI shows that there was a small financial advantage due to the larger crop in favor of plots S, which represent the double handling system. Table XII shows a much larger difference. There are two reasons for this: first, the superiority of plots S during the period subsequent to that covered by annual applications of manure was much greater than during the period in which manure was applied yearly; and, second, this superiority, as already pointed out, has shown a tendency to increase with lapse of time.

While it has previously been referred to, it seems desirable again to call attention to the fact that spreading manure during the winter helps to relieve the pressure of work in the spring, and therefore possesses some advantage which cannot be shown in dollars and cents, and which of course varies with the weather and other conditions affecting the spring work.

TABLE XII. — *Calculated Results per Acre (1912–19).*

CROP.	Crop Values, Yearly Average. Difference in Favor of Spring (Plots S).	Number of Years.	Total Difference in Favor of Spring (Plots S).
Mixed grass and clover,	$2 10	4	$8 40
Soy beans (ensilage),	24	1	24
Soy beans,	10 04	1	10 04
Corn,	12 73	2	25 46
Total,	-	8	$44 14

Average for 1 year, $5.52.

FINAL CONCLUSIONS.

1. Had the experiment been brought to a conclusion in 1911, the last year of the period during which manure was applied annually, the statement would apparently have been justified that it made little difference in financial result which of the two plans of applying manure should be followed. This, however, would not have amounted to a demonstration that excess wastage had not occurred on plots N, for the reason that in spite of such wastage under the conditions which had existed throughout the experiment, the supply of plant food on plots N had probably been adequate to give yields nearly as large as all the conditions affecting the yields on plots S made possible.

2. That the manure on plots N had suffered quite serious losses has been made apparent by the relative yields as compared with plots S during the period 1912–19, in which no additional manure had been applied.

3. There must have been considerable excess wastage on plots N, even had the rate of application been smaller, although, of course, the financial loss would have been less.

4. The conclusion which appears to me to be fully justified by the results obtained to date (1919) is that the manure for the crop of the following season should be incorporated with the soil by the plow or harrow after the removal of the crop in the late fall, if practicable, rather than spread upon the surface to remain until spring.

5. There can be little doubt that the excess wastage on plots N would have been less on land which was more nearly level than that used in this experiment, but the land surface in Massachusetts and throughout a large part of the New England States is so broken that the proportion of land so level that there is no wash over the surface is comparatively small.

6. The earlier start and more rapid growth on plots S, especially during the later years of the experiment, are a decided advantage, and in many cases go far to insure a superior crop on account of the fact that the moisture supply in the early part of the season is more surely adequate to the needs of the crop, as a rule, than later.

Yet in one other way the earlier start and more rapid growth which doubtless occur in the root system as well as in the tops help to insure a good crop. I would refer also to the fact that crops which develop early and rapidly are far more likely to escape serious injury by insect enemies than those starting late or growing slowly, both because better able to resist attacks of such enemies, and because capable of quickly replacing tissues which are eaten or injured. In the case of some parasitic diseases, also, the plant making an early start and rapid growth is less likely to be seriously injured.

7. The earlier maturity of the crop on plots S constitutes an important advantage in favor of such practice as will prevent excessive loss of plant food. This of course is particularly true of crops thriving at relatively high temperatures, such, for example, as Indian corn and soy beans.

8. There can be no doubt that there is some wastage of nitrogen from winter-spread manure, and nitrogen is, as a rule, the most costly of the different plant-food elements; but reduction of the amount of wastage of nitrogen through the practice of piling and spreading the manure to be immediately incorporated with the soil in the spring is not the only nitrogen advantage connected with that practice. Particular attention has been called to the far greater proportion of clover on plots S than on plots N. Under these relative conditions it appears certain that a much greater amount of nitrogen must be taken from the air, and either made

a part of the harvested portion of the crop or left behind in the stubble and roots, on plots S than on plots N, thus reducing materially the necessity for application of nitrogen to crops in later years.

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BULLETIN No. 197.

DEPARTMENT OF CHEMISTRY.

THE NUTRITIVE VALUE OF CATTLE FEEDS.

1. VELVET BEAN FEED FOR FARM STOCK.

BY J. B. LINDSEY AND C. L. BEALS.

Summary of Results with Suggestions.

1. Velvet bean feed consists of the ground seeds and pods of the velvet bean, a leguminous plant grown quite largely in the southern States.

2. In chemical composition it resembles wheat bran, but contains rather more fiber, due to the presence of the bean pods.

3. As a result of digestion studies it was found to contain about 130 pounds, or 11.5 per cent, more digestible organic nutrients per ton than does wheat bran, and as a component of the dairy ration one would expect somewhat better results from its use.

4. Two feeding experiments were made with groups of six and four cows, in which the ration consisted of hay and a grain ration of 20 per cent cottonseed meal, 40 per cent corn feed meal, and 40 per cent velvet bean feed or wheat bran. The results show that the cows while receiving the velvet bean ration produced 2.7 and 9 per cent, with an average of 5 per cent, more milk than while on the wheat bran ration. It seems safe, therefore, to conclude that the velvet bean feed is somewhat superior to wheat bran for dairy purposes.

5. It may constitute as high as 40 per cent of a dairy ration, together with a like amount of corn or hominy meal or ground oats, and some 20 per cent of cottonseed or linseed meal, or other high-grade protein concentrate.

6. As a food for pigs a ration composed by weight of 50 parts corn feed meal, 40 parts velvet bean feed, and 10 parts digester tankage

or one composed of equal weights of corn feed meal and velvet bean feed, did not prove as satisfactory as one composed of 90 parts corn feed meal and 10 parts digester tankage; and so large an amount of the velvet bean feed is not recommended.

7. A ration composed by weight of 20 parts velvet bean feed, 20 parts high-grade peanut meal, 50 parts corn meal, and 10 parts alfalfa meal gave as satisfactory results as one composed of 80 parts corn meal and 10 parts each of digester tankage and alfalfa meal; and such combinations are to be recommended.

8. The addition of 10 per cent ground alfalfa to the grain ration for growing pigs in order to supply the necessary vitamines did not seem to exert any marked effect in promoting growth.

9. As a feed for horses, velvet bean feed, if sufficiently dry to prevent decomposition, may comprise some 20 per cent of the grain ration, mixed together with 30 per cent oats, 40 per cent cracked corn and 10 per cent wheat bran.

10. It is important that the velvet bean feed should be well dried before being shipped, otherwise more or less decomposition is likely to set in, and the feed proves unsatisfactory for use. The writer regards a satisfactory quality of velvet bean feed as a distinct addition to the protein concentrates at the disposal of northern feeders.

11. Velvet bean meal (beans minus the pods) would undoubtedly prove more satisfactory for pigs and horses.

A. What Velvet Bean Feed is.

The velvet bean, of which there are many varieties, is a tropical legume, and is grown largely in Florida, Alabama and Mississippi. It needs a long season for its maturity, and is grown rarely north of Savannah. It is a rank grower, its vines trailing on the ground to a length of from 15 to 75 feet; they are difficult to cure for hay and have been used largely for grazing. It is now becoming common to pick the best of the beans and use them without hulling for cattle, or hulled as a food for pigs. The former is termed velvet bean feed, and the latter velvet bean meal. Machinery has more recently been devised for drying and grinding the unhulled beans, and it is said that the industry is increasing rapidly. About a year since, more or less of the velvet bean feed was placed upon the Massachusetts market, but it did not seem to give the best of satisfaction, partly on account of the feeders' lack of familiarity with the product, and partly because of its being shipped in too moist a condition.

Considerable has already been published relative to the velvet bean, particularly concerning its habitat, growth, adaptability to various soil and climatic conditions, as well as its suitability as a pasture crop, source of roughage, its value as silage and as a soil renovator.[1] Such information has a more particular value for parties residing in those States where the plant can be grown advantageously. Several experiments are also on record describing the feeding value of the ground bean and pods, and one experiment on its digestibility.

Inasmuch as the velvet bean feed (pods and beans) may become distributed in Massachusetts, experiments were undertaken at this station, particularly with reference to its digestibility and its suitability as a food for dairy stock, pigs and horses.

B. Composition of Velvet Bean Feed.

	Number of Analyses.	Water.	Ash.	Protein.	Fiber.	Extract.	Fat.
Velvet bean feed, . .	3	11.31	4.57	16.66	12.71	50.66	4.09
Wheat bran (for comparison),	116	10.00	6.20	16.10	10.00	53.30	4.40

The feed resembles wheat bran in chemical composition. It has slightly more protein, considerably more fiber, due to the presence of the bean pods, and somewhat less extract matter than wheat bran.

C. Digestibility of Velvet Bean Feed.

Two duplicate experiments were made with two different pairs of sheep. Two sheep were fed daily 550 grams of hay and 250 grams of the bean feed, and two other sheep 600 grams of hay and 200 grams of the feed. The results of the trials giving the amounts of the several constituents digested (digestion coefficients) are here stated, but the details of the experiments will be published elsewhere.

Results (Digestion Coefficients).

Sheep.	Dry Matter.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
XII, ...	82.06	41.48	76.64	81.07	89.71	86.69
XIII, ...	71.48	28.52	73.96	51.09	81.82	74.41
IX, ...	70.96	22.97	68.56	46.60	80.35	72.79
XI, ...	81.16	33.24	78.02	71.06	86.83	85.63
Average, ...	77	32	74	62	85	80
Average (Georgia station),[1] .	79	58	74	64	77	86
Average (all results), . . .	79	53	74	64	78	85
Wheat bran (for comparison), .	66	–	77	39	71	63

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[1] Farmers' Bulletins Nos. 300 and 962; Georgia Experiment Station Bulletin No. 129; Journal of Agricultural Research, Vol. XIII, No. 12, p. 611; Florida Experiment Station Bulletin No. 102.

Our own results with four sheep show some noticeable variations. Sheep XII and XI seem to have digested the feed better than the two other sheep. This variation is noticeable in each of the several ingredients. The average results agree quite closely with those secured by Ewing and Smith[1] with steers.

Applying the average coefficients to the chemical composition of the velvet bean feed we find 2,000 pounds of the material to contain the following: —

Digestible Organic Nutrients in 2,000 Pounds.

	Protein.	Fiber.	Extract Matter.	Fat.	Total.
Velvet bean feed, ...	246.6	162.6	790.2	69.54	1,268.94
Wheat bran (for comparison), .	248.0	78.0	756.8	55.40	1,138.20

Velvet bean feed contains about the same amount of digestible protein as does wheat bran. Its content of digestible fiber, extract matter and fat is somewhat in excess of that contained in the bran, and on the basis of total digestible organic nutrients it is shown to have some 11.5 per cent more feeding value than the latter feed.

D. Velvet Bean Feed for Cows.

During the fall and winter of 1918–19 two feeding experiments with velvet bean feed were made with milch cows. In one case six and in the other four animals were used. They were divided into groups in each experiment, and were fed by the reversal method for periods of five weeks (besides preliminary periods) on a ration composed of hay for roughage and a grain mixture made up of 20 per cent cottonseed meal, 40 per cent corn feed meal (corn meal in second experiment), and 40 per cent of either velvet bean meal or wheat bran.

Before starting the experiment the cows were carefully chosen and paired off as well as possible in regard to age, breed, period of lactation, yield of milk, fat, etc.

The hay and grain rations were carefully calculated for each animal on the basis of milk and maintenance requirements according to the Haecker Standards.[2] The general care and management of the animals in no way differed from that always used in our feeding experiments, and require no discussion here. Hay and grain samples were taken at regular intervals, composited and analyzed. Milk samples were taken on the first, third and fifth weeks of each half of each experiment.

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[1] P. V. Ewing and F. H. Smith in Journal of Agricultural Research, Vol. XIII, No. 12, p. 616. Results with five different steers in eighteen single trials.

[2] See Minn. Bul. No. 140, p. 56.

TABLE I. — *History of Cows.*

EXPERIMENT I.

NAME.	Breed.	Age (Years).	Last Calf.	Served.	BEGINNING OF EXPERIMENT.		
					Weight (Pounds).	Milk (Pounds).	Fat (Per Cent).
Samantha II,	Grade Holstein,	4	July 22, 1918,	– –	975	32	4.50
Peggy,	Grade Jersey,	8	Aug. 13, 1918,	– –	755	25	5.75
Red IV,	Grade Jersey,	5	Dec. 2, 1917,	June 2, 1918,	835	19	5.80
Samantha III,	Grade Holstein,	5	Aug. 26, 1918,	– –	1,140	30	4.60
Colantha III,	Grade Holstein,	4	Mar. 6, 1918,	June 12, 1918,	1,000	24	3.60
Fancy IV,	Grade Jersey,	4	July 22, 1918,	– –	700	21	4.63
EXPERIMENT II.							
Samantha III,	Grade Holstein,	5	Aug. 26, 1918,	Dec. 5, 1918,	1,170	25	4.60
Fancy IV,	Grade Jersey,	4	July 22, 1918,	Oct. 30, 1918,	810	18	5.35
Colantha II,	Grade Holstein,	4	July 22, 1918,	Nov. 7, 1918,	1,050	30	4.25
Ida II,	Pure Jersey,	6	Oct. 27, 1918,	Dec. 9, 1918,	800	28	5.60

TABLE II. — *Total Amount and Average Daily Amount of Food consumed per Cow and per Ration (Pounds).*

EXPERIMENT I.

Velvet Bean Feed Ration.

DATES.	COWS.	HAY.		VELVET BEAN MIXTURE.		WHEAT BRAN MIXTURE.	
		Total.	Daily.	Total.	Daily.	Total.	Daily.
Oct. 1–Nov. 4, 1918, .	Colantha II, .	840.00	24.00	350.0	10.00	–	–
	Peggy, . .	697.75	19.94[1]	315.0	9.00	–	–
	Red IV, . .	665.00	19.00	245.0	7.00	–	–
Nov. 15–Dec. 19, 1918,	Samantha III,	840.00	24.00	315.0	9.00	–	–
	Colantha III, .	735.00	21.00	280.0	8.00	–	–
	Fancy IV, .	665.00	19.00	245.0	7.00	–	–
Totals, . . .	. . . . .	4,442.75	–	1,750.0	–	–	–
Averages, . .	. . . . .	–	21.16	–	8.73	–	–

Wheat Bran Ration.

DATES.	COWS.	HAY.		VELVET BEAN MIXTURE.		WHEAT BRAN MIXTURE.	
		Total.	Daily.	Total.	Daily.	Total.	Daily.
Oct. 1–Nov. 4, 1918, .	Samantha III,	840.00	24.00	–	–	315.0	9.00
	Colantha III, .	735.00	21.00	–	–	280.0	8.00
	Fancy IV, .	642.00	18.91[2]	–	–	245.0	7.00
Nov. 15–Dec. 19, 1918,	Colantha II, .	840.00	24.00	–	–	350.0	10.00
	Peggy, . .	700.00	20.00	–	–	315.0	9.00
	Red IV, . .	665.00	19.00	–	–	245.0	7.00
Totals, . . .	. . . . .	4,422.00	–	–	–	1,750.0	–
Averages, . .	. . . . .	–	21.15	–	–	–	8.73

EXPERIMENT II.

Velvet Bean Feed Ration.

DATES.	COWS.	HAY.		VELVET BEAN MIXTURE.		WHEAT BRAN MIXTURE.	
		Total.	Daily.	Total.	Daily.	Total.	Daily.
Dec. 30, 1918–Feb. 2, 1919.	Samantha III,	840.00	24.00	315.0	9.00	–	–
	Fancy IV, .	665.00	19.00	245.0	7.00	–	–
Feb. 13–March 19, 1919,	Colantha II, .	840.00	24.00	332.5	9.50	–	–
	Ida, II, . .	735.00	21.00	332.5	9.50	–	–
Totals, . . .	. . . . .	3,080.00	–	1,225.0	–	–	–
Averages, . .	. . . . .	–	22.00	–	10.75	–	–

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[1] Peggy left a total of 2.25 pounds of hay, or a daily average of .06 pound unconsumed.

[2] Fancy IV left a total of 3 pounds of hay, or a daily average of .09 pound unconsumed.

TABLE II. — *Total Amount and Average Daily Amount of Food consumed per Cow and per Ration (Pounds)* — Concluded.

EXPERIMENT II — *Con.*

Wheat Bran Ration.

DATES.	COWS.	HAY.		VELVET BEAN MIXTURE.		WHEAT BRAN MIXTURE.	
		Total.	Daily.	Total.	Daily.	Total.	Daily.
Dec. 30, 1918–Feb. 2, 1919.	Colantha II, .	840.00	24.00	–	–	332.5	9.50
	Ida II, . .	735.00	21.00	–	–	332.5	9.50
Feb. 13–March 19, 1919,	Samantha III,	840.00	24.00	–	–	315.0	9.00
	Fancy IV, .	665.00	19.00	–	–	245.0	7.00
Totals, . . .	. . . . .	3,080.00	–	–	–	1,225.0	–
Averages, . .	. . . . .	–	22.00	–	–	–	10.75

TABLE III. — *Analysis of Feeds (Per Cent).*

EXPERIMENT I.

FEED.	Average Moisture.[1]	Dry Matter.[1]	DRY MATTER.				
			Ash.	Protein.	Fiber.	Extract Matter.	Fat.
Hay, ...	12.17 10.50	87.83 89.50	6.18	8.70	30.57	51.72	2.83
Velvet bean mixture, .	11.31 9.72	88.69 90.28	4.08	20.56	11.42	56.12	7.82
Wheat bran mixture, .	11.37 10.32	88.63 89.68	5.23	19.09	10.71	56.59	8.38

EXPERIMENT II.

FEED.	Average Moisture.[1]	Dry Matter.[1]	Ash.	Protein.	Fiber.	Extract Matter.	Fat.
Hay, ...	14.00 12.70	86.00 87.30	5.89	7.48	29.74	54.41	2.48
Velvet bean mixture, .	11.19 10.24	88.81 89.76	4.00	19.22	9.22	63.20	4.36
Wheat bran mixture, .	11.46 10.27	88.54 89.73	4.85	18.32	8.44	63.34	5.05

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[1] The two figures in each case represent the average of three samples taken in each half of the trials.

TABLE IV. — *Total and Average Daily Amount of Dry Matter consumed in Each Ration.*

EXPERIMENT I.

Velvet Bean Ration.

DATES.	HAY.		GRAIN.		GRAIN.	
	Total.	Daily.	Total.	Daily.	Total.	Daily.
Oct. 1–Nov. 4, 1918, . . . Nov. 15–Dec. 19, 1918, . .	3,940	18.76	1,566	7.46	–	–
Wheat Bran Ration.						
Oct. 1–Nov. 4, 1918, . . . Nov. 15–Dec. 19, 1918, . .	3,938	18.75	–	–	1,561	7.42
EXPERIMENT II.						
Velvet Bean Ration.						
Dec. 30, 1918–Feb. 2, 1919, . . Feb. 13–March 19, 1919, . .	2,669	19.06	1,894	7.81	–	–
Wheat Bran Ration.						
Dec. 30, 1918–Feb. 2, 1919, . . Feb. 13–March 19, 1919, . .	2,668	19.05	–	–	1,091	7.79

In each experiment the two rations contained the same amount of dry matter.

TABLE V. — *Average Dry and Digestible Nutrients in the Average Daily Ration (Pounds).*

EXPERIMENT I.

RATION.	Dry Matter.	DIGESTIBLE NUTRIENTS.					Nutritive Ratio.
		Protein.	Fiber.	Extract Matter.	Fat.	Total.[1]	
Velvet bean, . .	26.22	2.05	3.89	9.51	.77	16.22	1:7.4
Wheat bran, . .	26.18	1.97	3.74	9.24	.76	15.71	1:7.4

[1] Including fat multiplied by 2.2.

TABLE V. — *Average Dry and Digestible Nutrients in the Average Daily Ration (Pounds)* — Concluded.

EXPERIMENT II.

RATION.	Dry Matter.	DIGESTIBLE NUTRIENTS.					Nutritive Ratio.
		Protein.	Fiber.	Extract Matter.	Fat.	Total.	
Velvet bean, . .	26.87	2.24	3.87	11.87	.59	18.58	1:7.6
Wheat bran, . .	26.84	1.86	3.63	10.29	.53	16.31	1:8.1

The velvet bean ration contained rather more digestible matter than the wheat bran ration.

TABLE VI. — *Gain or Loss in Live Weight (Pounds) per Herd.*

RATION.	EXPERIMENT I.		EXPERIMENT II.		Total.
	Gain.	Loss.	Gain.	Loss.	
Velvet bean meal, ...	81	34	28	2	+73
Wheat bran, ...	135	0	32	8	+159

In the two experiments the cows when receiving the wheat bran ration seemed to gain a little more in weight than when receiving the velvet bean ration.

TABLE VII. — *Yield of Milk and Milk Ingredients.*

EXPERIMENT I.

Velvet Bean Ration.

DATES.	COWS.	Milk (Pounds).	SOLIDS.		FAT.	
			Per Cent.	Pounds.	Per Cent.	Pounds.
Oct. 1–Nov. 4, 1918, .	Colantha II, .	1,218.9	12.50	152.36	4.07	49.61
	Peggy, . .	885.8	14.89	131.90	6.30	55.81
	Red IV, . .	724.6	15.28	110.72	5.99	43.40
Nov. 15–Dec. 19, 1918,	Samantha III,	905.8	13.09	118.57	4.39	39.76
	Colantha III, .	830.8	12.67	105.26	3.83	31.82
	Fancy IV, .	672.0	13.82	92.87	5.21	35.01
Totals, . . .	. . . . .	5,237.9	–	711.68	–	255.41
Averages, . .	. . . . .	–	13.59	–	4.88	–

TABLE VII. — *Yield of Milk and Milk Ingredients* — Concluded.

EXPERIMENT I — *Con.*

Wheat Bran Ration.

DATES.	COWS.	Milk (Pounds).	SOLIDS.		FAT.	
			Per Cent.	Pounds.	Per Cent.	Pounds.
Oct. 1-Nov. 4, 1918, .	Samantha III,	948.7	12.89	122.30	4.47	42.41
	Colantha III, .	796.0	12.47	99.26	3.90	31.04
	Fancy IV, .	739.7	13.80	102.08	5.10	37.72
Nov. 15-Dec. 19, 1918,	Colantha II, .	1,163.0	12.69	147.58	4.01	46.64
	Peggy, . .	831.8	15.54	129.26	6.44	53.57
	Red IV, . .	620.5	16.14	100.15	6.47	40.15
Totals, . . .	. . . . .	5,099.7	-	700.63	-	251.53
Averages, . .	. . . . .	-	13.74	-	4.93	-

EXPERIMENT II.

Velvet Bean Ration.

Dec. 30, 1918-Feb. 2, 1919.	Samantha III,	763.8	13.49	103.03	4.64	35.44
	Fancy IV, .	596.0	14.70	87.61	5.32	31.70
Feb. 13-March 19, 1919,	Colantha II, .	1,260.0	13.40	168.84	4.51	56.82
	Ida II, . .	827.6	14.81	122.86	5.81	48.19
Totals, . . .	. . . . .	3,447.4	-	482.34	-	172.15
Averages, . .	. . . . .	-	13.99	-	4.99	-

Wheat Bran Ration.

Dec. 30, 1918-Feb. 2, 1919.	Colantha II, .	995.8	13.03	129.75	4.33	43.31
	Ida II, . .	862.9	14.74	127.19	5.85	50.47
Feb. 13-March 19, 1919,	Samantha III,	749.7	13.51	101.28	4.69	35.16
	Fancy IV, .	556.3	14.51	80.71	5.38	29.92
Totals, . . .	. . . . .	3,164.7	-	438.93	-	158.86
Averages, . .	. . . . .	-	13.87	-	4.99	-

In the first experiment an increase in milk yield of 2.7 per cent was secured, and in the second experiment an increase of 9 per cent, both in favor of the velvet bean ration.

In both experiments the velvet bean ration yielded 8,685.3 pounds, and the wheat bran ration 8,264.4 pounds, of milk, an average increase of 5 per cent in favor of the velvet bean ration.

In case of the velvet bean ration 100 pounds of dry matter produced 130 pounds of milk, and in case of the wheat bran ration, 125 pounds.

It seems evident, therefore, on the basis of digestibility and feeding experiments with dairy cows, that the velvet bean feed is somewhat superior as a dairy feed to wheat bran.

E. Velvet Bean Feed for Pigs.

Observations with two lots of pigs were made, the first in 1918 and the second in 1919.

Experiment I. — August 12–November 20.

Six pigs having reached a weight of about 50 pounds each were divided into three lots of two each, and fed on the following rations: —

Lot I. — Mixture by weight of 80 parts corn feed meal, 10 parts alfalfa meal and 10 parts digester tankage.

Lot II. — Mixture by weight of 50 parts corn feed meal, 40 parts velvet bean feed and 10 parts alfalfa meal.

Lot III. — Mixture by weight of 50 parts corn feed meal and 50 parts velvet bean feed.

The mixture fed to Lot I was considered a standard or check ration. That fed to Lots II and III was intended to demonstrate the efficacy of velvet bean feed in place of the tankage. Alfalfa was used in one ration and omitted in one to note if it aided, because of its "vitamine" content, in promoting growth.

Method of Feeding. — Ten ounces of each mixture were added to each quart of water to satisfy appetite. The grain mixture was at first mixed with a little cold water to convert it into a paste, then very hot water added, and the slop fed milk warm. The pigs were fed three times daily.[1]

Housing. — Each lot of pigs was kept in an outdoor pen, protected from rain and sun, and given the run of a small yard.

Weighing. — Each pig was weighed weekly on Monday morning before feeding.

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[1] An ash mixture composed of 20 per cent salt, 40 per cent rock phosphate, 10 per cent ground limestone and 30 per cent wood ashes was kept constantly before the pigs in all of the experiments here described. The pigs also had access to charcoal.

Record of Feeds consumed and of Growth (Pounds).

PIGS.	Days.	DRY MATTER IN FEEDS CONSUMED.					GROWTH.				Dry Matter required to produce 100 Pounds Live Weight.
		Corn Feed Meal.	Alfalfa.	Tankage.	Velvet Bean Feed.	Total.	Weight at Beginning.	Weight at End.	Total Gain.	Daily Gain.	
1	101	344.2	41.7	36.5	-	422.4	52.5	180.5	128.0	1.27	330
2, ...	98[1]	320.2	38.8	34.3	-	393.4	57.5	182.5	125.0	1.27	315
3, ...	62	90.5	18.0	-	72.3	180.8	47.5	80.5	33.0	.53	548
4, ...	101	179.3	35.6	-	143.2	358.1	49.5	118.0	68.5	.68	523
5, ...	72	119.2	-	-	119.1	238.3	44.2	83.5	39.2	.55	600
6, ...	72	115.1	-	-	114.9	230.0	52.2	82.5	30.2	.42	795

[1] Sick for three days.

Pigs 1 and 2 had the advantage in that they were fed corn meal and skim milk when very young. Pigs 3, 4, 5 and 6 were fed different grain mixtures when too young and did not get as good a start. Pig 3 was badly out of condition and did not recuperate until August. Pigs 1 and 2 were normal in every way, and on the diet of corn feed meal and digester tankage for 101 days gained daily 1.27 pounds and produced 100 pounds of live weight for 322 pounds of dry matter fed. Pigs 3 and 4, on the diet of corn feed meal, velvet bean feed and alfalfa, and pigs 5 and 6, on a corn feed and velvet bean feed diet, gained noticeably less. All appeared healthy during the experiment, and ate well. Pigs 5 and 6 did not grow quite as well as pigs 3 and 4, and did not appear to be building out as good a framework. It seemed evident that the alfalfa was furnishing something in promoting early growth that was lacking in the diet fed pigs 5 and 6.

Although the experiment was not as satisfactory as one could wish, it at least indicated that so large an amount of velvet bean feed was not desirable in the daily diet, and that it was not a satisfactory substitute for digester tankage.

Experiment II. — June 9–November 1.

Six pigs, grade Chester White, weighing from 24 to 34 pounds each, were divided into lots of two each and fed on three different rations, two of which contained 20 per cent velvet bean feed in order to test its efficacy as a component of a grain mixture.

Lot I received by weight a mixture of 80 pounds of corn meal, 10 pounds of digester tankage and 10 pounds of ground alfalfa.

Lot II received by weight a mixture of 50 pounds of corn meal, 20 pounds of peanut meal, 20 pounds of velvet bean feed and 10 pounds of alfalfa meal. On July 8 the corn meal was increased to 60 pounds, the alfalfa eliminated and different kinds of green material fed from day to day.

Lot III received by weight a mixture of 60 pounds of corn meal, 20 pounds of peanut meal and 20 pounds of velvet bean feed.

Lot I, therefore, received the so-called standard or check ration, Lot II the velvet bean ration plus alfalfa meal or green material to assist in promoting growth, while in the case of Lot III this was omitted. From September 7 to September 20 coconut meal was substituted for the velvet bean feed because of lack of supply of the latter. The method of feeding, housing and weighing was the same as in Experiment I.

Record of Feeds consumed and of Growth (Pounds).

Pigs.	Days.	Dry Matter in Feeds consumed.						Growth.				Dry Matter required per 100 Pounds of Gain.
		Corn Meal.	Peanut Meal.	Velvet Bean Feed.	Digester Tankage.	Alfalfa Meal.	Total.	Weight at Beginning.	Weight at End.	Total Gain.	Daily Gain.	
1, . .	175	476.5	-	-	62.9	60.6	600.0	22	185	163	.93	368.1
2, . .	175	476.5	-	-	62.9	60.6	600.0	30	195	165	.94	365.0
3, . .	175	344.6	124.5	119.6[1]	-	4.4	593.1	27	162	135	.77	439.3
4, . .	175	344.6	124.5	119.6[1]	-	4.4	593.1	25	189	164	.94	361.6
5, . .	175	347.7	124.0	119.1[1]	-	-	590.8	34	185	151	.86	391.3
6, . .	175	347.7	124.0	119.1[1]	-	-	590.8	27	173	146	.83	404.6

[1] Includes 21.4 pounds of coconut meal.

Each of the pigs remained in a thrifty condition during the entire experiment, and from their looks one would not be able to say that one ration was proving more effective than another.

Lot I, receiving the corn and tankage mixture, made an average daily gain of .93 pound each, and required 366 pounds of dry matter to make 100 pounds of gain. An average for pigs of this size is .9 pound of gain daily, and a requirement of 377 pounds of dry matter per 100 pounds of gain.

Lot II, receiving the corn, velvet bean, peanut and ground alfalfa, made an average daily growth of .85 pound each, and required 400 pounds of dry matter for 100 pounds of gain. Pig 4 of this lot gained fully as well as either of the two pigs in Lot I, but for some reason, due perhaps to individuality, pig 3 made somewhat less daily gain.

Lot III, receiving substantially the same ration as Lot II, with the exception of the alfalfa, made an average daily gain of .85 pound each, and required 398 pounds of dry matter per 100 pounds of gain. This latter lot did not do quite as well as Lots I and II, indicating possibly that the lack of alfalfa may have slightly checked growth, but the difference was so slight as not to warrant one in drawing any positive conclusions. The combination of corn meal, alfalfa, velvet bean feed and peanut meal gave as satisfactory results as corn meal and tankage, and indicates that some 20 per cent of velvet bean feed, when properly combined, can be used as a component of the ration for growing pigs.

A ration containing 40 to 50 per cent of velvet bean feed together with corn meal (Experiment I) proved unsatisfactory and its use in such amounts is not recommended.

F. Velvet Bean Feed for Horses.

Velvet bean feed of good quality was fed to two farm horses for a period of three months, comprising some 18 per cent of the daily grain ration, which was as follows: —

Grain Mixture.

	Pounds.
Oats,	100
Corn,	140
Wheat bran,	40
Velvet bean feed,	60

The horses received from 17 to 20 pounds daily of the mixture, did regular farm work and maintained their live weight. Velvet bean feed, if dry and free from mold, can be used in the amounts indicated with safety.[1]

Velvet bean meal (beans minus pods) would undoubtedly prove better suited as a feed for pigs and horses.

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[1] For a fuller report, see Bulletin No. 188, pp. 259-262.

BULLETIN No. 198.

DEPARTMENT OF CHEMISTRY.

STUDIES OF CRANBERRIES DURING STORAGE.

CHEMICAL STUDIES.

BY F. W. MORSE AND C. P. JONES.

Chemical Changes in Cranberries in Storage.

For several years the Massachusetts Agricultural Experiment Station has been studying problems connected with the storage and shipment of cranberries, during the course of which chemical data have been gathered that are here arranged to show the composition of a few well-known varieties of cranberries and some of the changes which take place in their composition while they are held in storage.

The essential qualities of a fruit that is to be used for cooking or dessert are juiciness and flavor. With our present knowledge of analytical chemistry such qualities can be measured only in terms of water, sugar and acid, since as yet there are no sure methods for determining the characteristic fruit flavors or esters. Therefore determinations of water, total sugar and total acid were made in all our samples of cranberries, while the proximate analysis of the food constituents was executed on some of them.

The analyses of varieties have been selected as far as possible to show them at their best. The Early Black and the Howes varieties were sampled in October from lots stored at natural temperatures, while the McFarlin and Centennial varieties were sampled in November from lots in cold storage. Early Black is the earliest variety shipped from the Cape Cod district. It is of good quality, but is not a good keeper. Howes is a later variety and forms the main crop on many of the bogs. It is a good keeper, but is not equal to some other varieties in quality. The other two varieties are rated among growers as "fancy" kinds, and are grown in limited quantities. The McFarlin is an excellent variety in quality, but not as good a keeper as Howes. The Centennial is a very large berry, attractive on account of its size, of good flavor, but not as juicy as the others. Cranberries, however, are not sold under their variety names, like apples, but usually bear brands, originated by the sales organizations, which are unrelated to the varieties.

Two lots of Wisconsin cranberries were sent to the laboratory from that State by Dr. N. E. Stevens. One variety was the well-known McFarlin, and the other was a fancy western variety, of attractive size and color, called Searl's Jumbo. The sugar content was a bit inferior to our Cape varieties in both samples, but the fruit was sent by parcel post in tight packages, and was probably in warm mail cars and rooms while in transit. Such conditions induce a somewhat rapid change in sugar content, as shown by our storage experiments.

The composition of the varieties is shown in the following table: —

TABLE I. — *Composition of Varieties of Cranberries in October.*

VARIETY.	Water.	Total Sugar.	Total Acid.
Early Black, ...	87.86	4.12	2.45
Howes (two lots), ...	87.44	3.95	2.31
McFarlin, ...	88.74	4.08	2.12
Centennial, ...	87.16	5.59	2.05
Searl's Jumbo (Wisconsin), ...	89.25	3.48	2.61
McFarlin (Wisconsin), ...	88.47	3.75	2.49

Proximate Food Constituents.

VARIETY.	Dry Matter.	Ash.	Protein.	Fiber.	Ether Extract.	Nitrogen-free Matter.
Howes, ...	12.23	.15	.35	1.51	.97	9.25
McFarlin, ...	11.26	.16	.35	1.18	.57	9.00
Centennial, ...	12.84	.17	.28	1.15	.51	10.73

It has been noted that the cranberries undergo some change in composition during the storage period, although they remain firm and sound, with no evidence of decay. The change is most pronounced when the fruit is held at the higher temperatures of storage in a warm room, and is barely noticeable at cold-storage temperatures just above the freezing point.

In the fall of 1917 changes in the fruit during storage were studied by the analysis of berries kept in the storehouse at the cranberry bog. Fruit of the Howes variety was sent to the laboratory at monthly intervals directly from the storehouse, by express or parcel post, in small, ventilated crates holding about 8 quarts. The first lot was shipped in October, soon after the fruit had been stored, and the final lot in February. No attempt was made to ascertain the shrinkage in weight of the fruit during storage, since berries were all the time decaying, and no lot of selected fruit would fail to have more or less rotten berries in a week's time, and such berries lose water more rapidly than sound ones. To have correctly determined losses in weight of sound fruit over a period of months would have required the individual weights of a large number of berries, so that decayed berries could be rejected as they developed, and only sound berries weighed individually at the end of a given period. The chemical analyses included determinations of water, total sugar and total acid.

In 1918 the work was repeated in a similar manner with samples from the bog storehouse. In addition, several lots of cranberries were placed in the cold-storage rooms of the Horticultural Department about the middle of October, and samples were analyzed at intervals to compare their rate of change with the changes in the cranberries kept at the bog. The cold-storage house was built especially for fruit storage, and the fruit in it is held almost constantly just above 0° C. (32° F.).

The composition of the berries under different conditions of storage is shown in Table II.

TABLE II. — *Composition of Cranberries in Storage, 1917–19.*

	Dry Matter.	Total Sugar.	Total Acid.
Howes Variety.			
Storehouse: —			
Oct. 5, 1917,	12.89	3.97	2.28
Oct. 17, 1917,	-	3.85	-
Oct. 31, 1917,	11.81	-	-
Dec. 3, 1917,	11.58	3.27	2.32
Jan. 3, 1918,	11.76	3.47	2.37
Jan. 28, 1918,	11.78	3.58	2.26
Oct. 16, 1918,	12.23	3.93	2.34
Nov. 21, 1918,	12.06	4.19	2.15
Dec. 19, 1918,	12.10	4.18	2.01
Cold storage: —			
December, 1918,	12.14	4.04	1.96
January, 1919,	12.50	3.89	2.14
February, 1919,	12.54	3.72	2.17
McFarlin Variety.			
Cold storage: —			
November, 1918,	11.26	4.08	2.12
January, 1919,	11.59	4.09	2.12
Centennial Variety.			
Cold storage: —			
November, 1918,	12.84	5.59	2.05
January, 1919,	13.11	5.54	2.08

The samples for analysis invariably consisted of the firm, hard berries, with no evidence of decay. Some of the analytical results make it appear possible that selected lots of berries like these do not necessarily show progressive changes in composition for the average fruit of the early part of the season, but that the later berries are resistant to decay by less active cell organization and lower rate of metabolism.

In 1917 the Early Black cranberries picked from the little bogs at the Experiment Station were sampled and analyzed on September 25, soon after picking. The remainder was divided into two portions, one of which was placed in a refrigerator, and the other was left on a shelf in the basement at a temperature a little above the outside air on the average. These lots were sampled and analyzed four weeks later. The two lots were then allowed to stand until January, 1918, when the refrigerator lot was freed from all soft berries and sampled; while the lot from the basement was divided into two portions, one consisting of firm, sound berries, and the other, while free from rotten fruit, consisting of berries that were soft and rubber-like in physical appearance. Analyses of these lots of berries showed some striking differences.

TABLE III. — *Composition of Early Black Cranberries under Different Conditions of Storage.*

	Total Solids.	Total Sugar.	Total Acid.
Recently picked, September 25, ...	12.14	4.12	2.45
Two weeks later, October 8, ...	–	4.48	2.36
From refrigerator, October 23, ...	–	4.17	2.49
From basement, October 23, ...	–	3.99	2.43
From refrigerator, January, ...	11.01	3.51	2.35
From basement, January, firm, ...	10.59	2.62	2.55
From basement, January, soft, ...	11.76	2.75	2.63

The character of the package in which cranberries are stored and shipped has been closely related to changes in the properties of the fruit. In the course of storage investigations, made to determine the causes of cranberry spoilage after harvesting, Shear and Stevens observed a considerable number of berries that were soft, but which contained no organisms of decay.[1] Since the more thoroughly oxygen was excluded from the fruit the larger the quantity of softened berries, the trouble appeared to be caused by the lack of ventilation, and the berries were regarded as asphyxiated.

In December, 1917, Dr. Stevens brought to the laboratory directly from Washington several lots of Howes berries that had been stored in small cans from which the air had been displaced by carbon dioxide gas. The fruit had been held in these cans for two months at different temperatures, viz., 0°, 5°, 15° and 20° C. (32°, 41°, 59° and 68° F.). Some berries at each temperature still remained firm and sound, although at 20° C. there were not enough for a satisfactory analysis. The softened berries had been attacked by the end rot fungus in most cases, but from the lot held at 0° C. enough typically asphyxiated berries were secured for chemical examination. The analyses of the sound berries showed a slightly lower sugar content at the higher temperatures, with practically no changes in water and acidity. The asphyxiated berries, although kept at the lowest temperature, contained much less sugar than any of the sound berries, indicating a much more destructive action on the fruit sugar when oxygen was lacking.

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[1] Proc. Amer. Cranberry Growers' Assoc. 48 (1917), pp. 6–9. Mass. Agr. Expt. Sta. Ann. Rept. 30 (1918), pp. 235–239.

TABLE IV. — *Howes Cranberries stored at Fixed Temperatures.*

	Water.	Total Sugar.	Total Acid.
Sound berries at 0° C.,	88.30	3.56	2.25
Sound berries at 5° C.,	88.29	3.51	2.29
Sound berries at 15° C.,	88.45	3.37	2.24
Asphyxiated berries at 0° C.,	–	2.38	2.40

A small sample of asphyxiated berries with but little evidence of rot about them was selected from the combined lots stored at 15° and 20° C. The determination of sugar in this sample showed but 2.04 per cent.

It is a common practice in the household to preserve cranberries by sealing them in jars filled with water. One experiment was tried to determine the effect of such treatment on the composition of the fruit.

Two fruit jars were filled with cranberries from the lot of Howes received from the Experiment Station bog in October. Distilled water was added to the jars until they were brimful, when the covers were put on and clamped as in canning fruit. The jars were set away in a cool room and allowed to remain until February. When the jars were opened the water was found to contain carbon dioxide which escaped in bubbles as soon as the pressure on the covers was released. The fruit showed no signs of rot, but every berry was softened and felt like rubber. The water contained acid, sugar and coloring matter that had diffused from the fruit. The berries contained 10.36 per cent dry matter, 2.85 per cent sugar and 1.87 per cent acid, — quantities considerably less than in the same kind of berries stored in a cool room. While decay had been prevented, the absence of air had produced results similar to the asphyxiated fruit previously described.

The results of these different experiments show a steady loss of sugar by cranberries during storage, and this loss is greater at the higher temperatures, while the destruction is further accelerated by a lack of air. The total acidity changes were very little, hence on account of its high proportion in cranberries they do not lose flavor on long keeping as noticeably as some other fruits.

Respiration of Cranberries.

The percentage changes in the composition of fruits produced by different storage temperatures throw little light on the real rate of change at a given temperature. A simple method of estimating the rate of chemical change in fruit at any given temperature is to determine the amount of carbon dioxide exhaled by a definite weight of the fruit in an hour. The carbon dioxide is produced by respiration of the fruit, just as it is produced in animals by the same action. The oxygen of the air penetrates the cells[1] of the fruit and unites with some of the matter in the cells, apparently the sugar, and forms carbon dioxide and water which are exhaled. There is no appearance of rhythmical action, as in the breathing of animals, but the exhalation of the carbon dioxide and water can be readily determined by chemical means.

Respiration experiments with several kinds of fruits[2] have been reported, and it has been shown that respiration varies noticeably with changes in the temperature of the fruit.

Respiration experiments with cranberries were carried out during two seasons, 1917–18 and 1918–19. One kilogram of cranberries was used in nearly every case, and whenever possible for convenience in calculation. The berries were carefully hand-sorted before weighing the desired quantity, in order to avoid any berries which had begun to rot. It was impracticable to hold the cranberries closely to a given degree of temperature during a run, and it was found necessary to maintain them for several hours before a run as closely as possible to the temperature desired to be tried in the respiration chamber, because the internal temperature of the berries was slow to adjust itself to that of the chamber if they were far apart, and the exhalation of carbon dioxide might be too high or too low accordingly. By close attention to details and to the thermometer, the range of temperature during any one run was kept within one or two degrees. Several different temperatures were tried, from about 2° to 25° C. (35° to 77° F.). The lowest temperatures were obtained by setting the respiration chamber inside a small tank which could be packed with snow. Temperatures around 10° C. were obtained at times by surrounding the chamber with running water, and at others by carrying on the runs in a cool basement. A warm room, such as the laboratory, served for the higher temperatures.

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[1] The authors' attention has been called by Dr. Stevens to a little-known paper by Winton (Conn. Agr. Expt. Sta. Ann. Rept. 1902, p. 288), in which is noted the absence of stomata in the epidermis of the cranberry. Bergman, while studying the cranberry, rediscovered this fact, and a paper by him is in press in the bulletin of the Torrey Botanical Club.

[2] Morse, Jour. Am. Chem. Soc. 30 (1908), pp. 876–881; N. H. Agr. Expt. Sta. Bul. No. 135 (1908). Gore, U. S. Dept. Agr., Bur. of Chem. Bul. No. 142 (1911). Hill, Cornell Univ. Expt. Sta. Bul. No. 330 (1913).

The results given in the following table are selected from a large number of trials, and are those in which the fruit, before and during the experiment, underwent a narrow range of temperature.

TABLE V. — *Exhalation of Carbon Dioxide by One Kilogram of Cranberries in One Hour.*

SURROUNDINGS.	Temperature (Degrees C.).	Determinations.	Milligrams CO_2.
Packed snow,	1–3	5	3.7
Cold room,	6–7	3	7.0
Running water,	9–11	5	7.7
Running water,	11–13	6	9.7
Warm room,	17–20	4	15.4
Warm room,	19–21	3	16.9
Warm room,	22–25	2	18.7

It will be readily seen that the amount of carbon dioxide exhaled doubled with a rise of 10° C. in temperature, which is in accord with the general law for the acceleration of chemical activity.

The temperatures of practical importance are those of cold storage, cool storehouses and warm rooms, or temperatures of 1° to 3°, 9° to 11°, and 20° to 25° C. Cranberries in a warm room are respiring from four to five times as fast as fruit in cold storage, while the fruit in a cool storehouse is twice as active as in cold storage.

These respiration experiments serve to confirm and explain the disappearance of sugar in the cranberries during storage and the increase in such loss at higher temperatures. The rate of respiration helps to explain the asphyxiation of the cranberry described by Shear and Stevens.

By packing cranberries in glass jars and then measuring the amount of water required to fill the air spaces remaining, it was found that in tightly packed barrels of the fruit there could not be more than 75 cubic inches of air for each quart of berries. Since only one-fifth of the air consists of oxygen, it was calculated that in about thirty-six hours, at the cool temperature of 10° C. (50° F.), the cranberries would exhaust the oxygen and replace it with exhaled carbon dioxide. Therefore, if there were no exchange of air between the outside and the inside of a barrel of cranberries, it would be only a few hours before asphyxiation would begin. Fruit, however, does not die as quickly as animals in the absence of air. There is a form of respiration called intracellular respiration, by which sugars decompose to alcohol and carbon dioxide. This is always the result with yeast in alcoholic fermentation. Similar results are found with fruits. Carbon dioxide has been found to be exhaled by fruit in nitrogen gas[1] at about the same rate as by fruit in air. The destruction of sugar under such conditions is theoretically twelve times as great as when oxygen is available.[2]

In our work with cranberries the rate of destruction of sugar in tight packages was shown to be much greater than in well-ventilated ones. At the same time, it was noted that many berries were very resistant to the conditions, and showed little or no signs of asphyxiation. It is possible that such berries have a lower rate of chemical activity, because, as Gore[3] has shown, the varieties of fruit which may be kept a long time, like oranges and lemons, have a much lower rate of respiration than fruits like grapes and strawberries, which spoil quickly.

A third study of the rate of respiration was made in January and February, 1920, with the object of learning whether the different varieties varied in their activity at a given temperature. It was necessary to have as constant a temperature as could be maintained with the means at our disposal. Through the co-operation of the Pomology Department we were enabled to carry on the work in one of the cold-storage rooms in which the temperature changes were comparatively small and slow, and the different varieties were studied under closely comparable conditions.

The cranberries were received from the Experiment Station bog in November, 1919, and had been held in a room with apples at a temperature of 32° to 33° F., until the respiration experiment was reached in January. They were then transferred to the room in which the respiration apparatus was set up, so that they would be at the temperature of the trial at all times. Four varieties of cranberries were used. The Howes variety was studied, with especial attention to possible changes in the rate of respiration as the storage period advanced, and the other varieties were compared with the Howes and with each other, as there was opportunity. A fresh lot of berries was taken from the crate and carefully hand-sorted for each day's trial in order to exclude any unsound fruit. The experiment was conducted as in all the previous cases.

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[1] Hill, Cornell Univ. Agr. Expt. Sta. Bul. No. 330.

[2] Palladin, Plant Physiology, tr. by Livingston, Blakiston, 1918, p. 180.

[3] Gore, U. S. Dept. of Agr., Bur. of Chem. Bul. No. 142.

TABLE VI. — *Exhalation of Carbon Dioxide by Varieties of Cranberries.*

DATE OF EXPERIMENT.	Temperature of Berries (Degree C.)	MILLIGRAMS CO_2 PER KILO AND HOUR.			
		Early Black.	McFarlin.	Centennial.	Howes.
January 19,	1.2	3.9	–	–	–
January 20,	.6	–	4.8	–	–
January 21,	.4	–	–	5.6	–
January 22,	1.9	–	–	–	4.8
January 27,	2.1	2.6	–	–	–
January 28,	1.7	–	4.9	–	–
January 29,	2.0	–	–	4.7	–
January 30,	1.7	–	–	–	4.2
February 3,	1.5	3.7	–	–	–
February 4,	2.3	–	4.9	–	–
February 5,	1.8	–	–	5.0	–
February 6,	3.0	–	–	–	4.7
February 11,	3.4	–	5.8	–	–
February 12,	3.2	–	–	5.7	–
February 13,	3.0	–	–	–	4.9
February 16,	3.0	–	5.0	–	–
February 17,	2.3	–	–	–	4.2
February 25,	3.9	–	–	–	4.3
February 26,	3.6	–	–	4.7	–

The table shows a pronounced difference between the Early Black and the Centennial in the rate of respiration, but very little, if any, between the Howes, McFarlin and Centennial. There is a slight indication of a decrease in activity by the Howes as the storage period lengthened. Theoretically this decrease should occur, but on account of other variables it is not readily demonstrated. Since Early Black had passed its prime for quality at the date of the experiment, it is possible that its lower activity was due to a loss of vitality.

KEEPING QUALITIES OF CRANBERRIES IN COLD STORAGE.

Some simple tests of the keeping qualities of cranberries in cold storage have been made in connection with the chemical studies, since it was necessary to have a considerable quantity of fruit on hand to insure plenty of sound berries throughout the season. When the cranberries were received from the substation at East Wareham, they were placed in the cold-storage house at the College under the same conditions that were maintained for apples. The cold-storage house is a modern building in which the temperature can be kept practically constant week in and week out, which for apples is just above the freezing point, or between 32° and 33° F. The cranberries were stored in ventilated crates holding a half barrel each. There was some evidence that the berries in the center of a crate decayed a little more than those near the surface, but these crates are as small as will be economical for storage and transportation.

When a sample of fruit was required for the chemical studies, a quantity of berries was removed from a crate, carefully sorted by hand, and the different portions weighed. Especial care was taken to have only perfect fruit for the chemical experiments; therefore some berries were rejected which would have been included among sound fruit by the ordinary methods of sorting for the trade. The shrinkage was consequently somewhat greater than would occur in practical storage. The relative keeping qualities of the different varieties should hold, however.

In the fall of 1918 the cranberries were received at the Experiment Station on September 26, kept in a cool room until October 3, and then placed in cold storage with apples. The first lots were removed on November 20, and others at intervals until February 18. The percentages of perfect fruit are given in Table VII.

For the season of 1919 the cranberries were received in November and placed at once in the storage room with apples. Previously they had lain in the store room at the bog in East Wareham at natural temperatures. The first lot was taken from cold storage on Jan. 13, 1920, at which time the crates were removed to a room without ice for the subsequent respiration experiments, but at no time was the temperature observed to go above 37° or 38° F. in this room, which was insulated from outside temperature changes. In this series of tests one variety was used at a time, but all were examined within a week, so in the table below the dates are given for weeks instead of definite days in which berries were sorted.

TABLE VII. — *Keeping Quality of Cranberries. (Per Cent Sound Fruit.)*

DATE.	Early Black.	Centennial.	McFarlin.	Howes.
1918-19.				
November 20,	–	86.5	74.5	–
December 16,	38.3	–	–	–
January 14,	–	68.0	55.0	78.5
February 18,	–	–	–	75.0
1919-20.				
January 13-20,	46.3	60.6	63.7	64.9
January 27-February 4,	42.5	51.8	53.2	58.5
February 12-17,	–	44.9	52.0	62.1

It is evident from the results that Howes was the only variety that would keep well enough to make storage possible until midwinter in order to extend the marketing season. The other varieties, however, are better in eating qualities, and might be used for the manufacture of jam and jelly in seasons of abundant crops.

Cranberry Vinegar.

In September, 1918, an early frost injured many acres of cranberries, and the question was asked of the Experiment Station whether it was possible to utilize the frosted fruit as a source of vinegar. Consequently a lot of the frozen berries was secured by Dr. Franklin for the preparation of some juice for a fermentation experiment. It was found impossible with a machine to separate rotten berries from the fruit softened by the frost, and the cranberries were used without sorting.

The juice was pressed from the berries early in October by means of a hand cider mill. A lot of juice from sound fruit was prepared at the same date for comparison with regard to quality. Both lots of juice possessed a very disagreeable, bitter, acid taste. They remained under favorable conditions for fermentation until December 19, when they were received at the chemical laboratory for analysis.

Careful tests were made for alcohol in the juice by repeated distillation to concentrate it, and the application of the iodoform reaction to the final distillates. Neither juice showed more than a trace of alcohol in the final reaction, so that little fermentation had occurred.

Total acid and total sugar were determined in the different juices by the methods employed for the cranberry analyses. The results were found to be 2.3 per cent acid and .8 per cent of sugar in the juice from frozen berries, and 2.9 per cent acid and 2.6 per cent sugar in the juice from sound berries. Had the sugar all fermented to acid there would not have been sufficient strength to make a legal vinegar, while the taste would condemn its use in any case. Freezing resulted in a marked lowering of sugar in the fruit. The failure to ferment freely is probably due to the benzoic acid, which is a natural constituent of the cranberry. It does not appear practicable to utilize waste cranberries for vinegar.

Summary.

This bulletin reports the results of a chemical investigation made on the changes taking place in stored cranberries.

After the cranberries are picked from the vines they still remain living organisms. Storage conditions should be such that the life of these organisms may be prolonged instead of death being hastened.

Cranberries lose some of their sugar during storage. This loss is due to the respiration of the living berries, which respiration is less rapid at low temperatures than at high temperatures. For this reason the warmer the berries are kept the greater the loss of sugar during storage.

In order to have complete respiration, berries require a constant supply of oxygen during storage. Without this they become asphyxiated and die prematurely.

Good storage must include control of both ventilation and temperature.

METHODS.

FOR THE DETERMINATION OF CHEMICAL COMPOSITION.

In drying the cranberries for the determination of water it was necessary either to puncture the skin of the berry in numerous places with a pin, or to cut it into quarters with a knife. Fifty grams of cranberries were punctured or cut in pieces and spread in a shallow glass dish which was placed in a drying oven at a temperature between 50° and 60° C., where it remained until the fruit was brittle enough to be easily pulverized. The dish and contents were then cooled in the open air and the weight of dried material ascertained, after which it was pulverized and stored in a tightly corked bottle. Weighed charges of the air-dry material were subsequently used for moisture determinations, and the total water content of the cranberries calculated.

For the determination of sugar and acid, 50 grams of cranberries were mashed, a few at a time, in a porcelain mortar and washed with water into a 500 cubic centimeter volumetric flask by the aid of a wash bottle, short-stemmed funnel and long glass rod. The flask and contents, which amounted to 300 cubic centimeters, were set on a boiling water bath and allowed to stand about one hour. The flask was frequently shaken, and the pulp and water finally made a fairly homogeneous mass through which the sugar and acid were diffused. The liquid was cooled to room temperature and made up to 500 cubic centimeters. The flask was shaken and the contents then poured on a fluted filter large enough to hold the whole. The funnel was covered and a flask used to catch the filtrate so that evaporation would be reduced as much as possible. Aliquots of 100 cubic centimeters were used for sugar determinations, which were limited to the total sugar after inversion. Clarification was accomplished with Horne's dry lead subacetate, and the soluble lead in the cleared solution was removed by dry sodium carbonate.

Total acidity was determined in aliquots of 25 cubic centimeters of the cranberry solution, which were diluted with several volumes of water and titrated with tenth-normal sodium hydrate, using phenolphthalein as the indicator. The pink color of the cranberry solution seemed at first to make the use of an indicator almost impracticable, but the cranberry pigment proved to be a crude indicator itself. As the alkali was added the pigment changed from pink to blue, and subsequently faded to a pale green as more alkali was introduced. The end point was clearly marked by the appearance of a dark purple tint when the turning point of phenolphthalein was reached. The total acid was calculated as citric acid, though benzoic acid[1] and malic acid[2] have been shown to occur in small quantities in the cranberry.

The proximate food constituents — ash, protein, fiber, ether extract and nitrogen-free matter — were determined in the dried material by the standard methods.

Ether extract from the cranberry is a mixture of true fat from the seeds, wax from the skin and more or less of the fruit acids, — citric, malic and benzoic, — all of which are soluble in ether, the last most easily. In some of the samples the ether extract was warmed with the addition of water, and its acidity determined, but as it could be only an approximate correction it was thought best to leave the total ether extract uncorrected for acids present in it.

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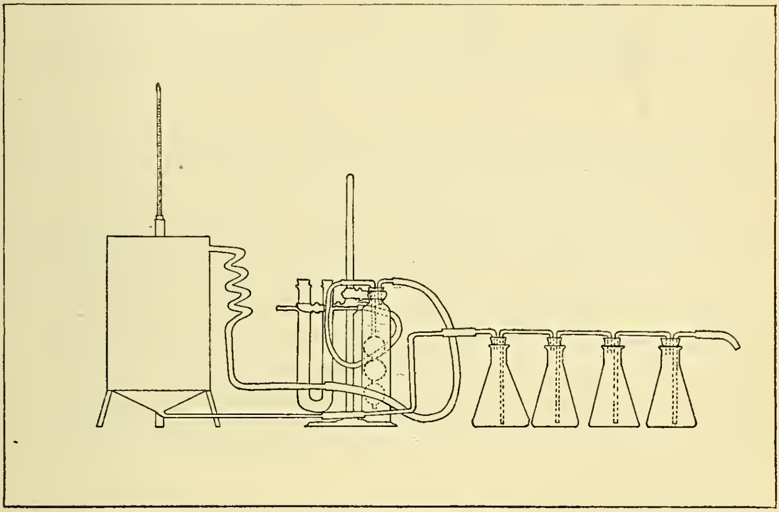
[1] Mason, Jour. Am. Chem. Soc. 27 (1905), p. 613.

[2] Bigelow and Dunbar, Jour. Indus. and Engin. Chem. 9 (1917), p. 762.

For the Determination of Rate of Respiration.

The apparatus consisted of a respiration chamber into which air freed from any carbon dioxide could be drawn, and from which the air could be conducted through a liquid which would absorb all of the exhaled carbon dioxide carried along in the current.



Respiration Apparatus.

The respiration chamber was of tin and would hold about 3 quarts. It was open at the top and was closed by a disk of tin which rested on a narrow shelf extending around the inner wall a half inch below the top. The bottom was funnel-shaped with the outlet for the exhaled gas projecting from the lowest part, so that the carbon dioxide, which is heavier than air, could be completely removed. The inlet for purified air was just below the cover of the chamber. Inside the chamber was a loose, false bottom, perforated with numerous small holes, which prevented the cranberries from settling down and blocking the outlet. The false bottom supported a tube three-eighths of an inch in diameter which rose through the center of the chamber and projected an inch above the cover. This tube was also perforated with holes in the portion below the cover, and served to hold a thermometer and to permit free circulation of air through the mass of berries. The cover was sealed in place by means of putty around the inner walls and the central tube, and a cork, through which passed the thermometer, stopped the tube. The outer end of the inlet tube was joined to the purification apparatus which consisted of a U tube containing dry soda lime, and a bulb tube containing a strong solution of sodium hydroxide. The air bubbling through the solution was moistened before entering the chamber, while the bubbles marked the movement of the air and served to indicate leaking joints. The outlet tube connected with a train of four small flasks, each of which contained a measured amount of standard solution of barium hydroxide, by which all the carbon dioxide was absorbed and precipitated as barium carbonate. A current of air was drawn through the entire apparatus by an aspirator which was regulated so that the air in the respiration chamber would be renewed about once in every hour. As a rule, each experiment was run six hours. Some were conducted for longer periods, but six hours was most convenient and satisfactory.

FUNGI STUDIES.

BY BERT A. RUDOLPH AND H. J. FRANKLIN.

Relative Prevalence of Fungi causing Rots of Cranberries at Different Periods during the Storage Season.[1]

Decay of cranberries in storage has been reported to be caused by more than ten species of fungi. The study of these storage rots and their control is complicated by the fact that the fungi causing them vary greatly in their relative abundance during different seasons. Moreover, berries from the various bogs within a given region are often found to be affected with different fungi, and there is apparently some difference in varieties on the same bog. Finally, in any given lot of berries there seems to be a more or less definite succession among the fungi causing decay during the storage period. The present paper deals especially with the last-mentioned point.

The plan of work in 1916–17 was as follows. Twelve storage boxes (1 bushel capacity) were filled with Early Black cranberries from a uniform area on the station bog at East Wareham, Mass., and placed in storage in the basement of the screen house, together with a similar lot of Howes. Beginning September 27 quart samples of sound berries were selected weekly from each variety and stored for two weeks in quart cans (which were closed but not sealed) at room temperature, after which they were sorted, and the berries which had rotted during the two weeks were sent to Washington. Here at least 60 cultures were made[2] from each lot of rotten berries by sterilizing the outside of the berry by immersing for five minutes in mercuric chloride solution (1–1000) and transferring a portion of the pulp to culture media by means of sterile forceps. In case fungi developed which did not fruit readily on the culture medium first used, subcultures were made on oat, beef, glycerine and corn-meal agar.

In the work of the season of 1917–18 the method was modified in several particulars. Closed cans were abandoned in favor of open boxes for the storage of the selected sound berries, the interval between tests was four weeks, and the sound berries selected for each keeping test were divided into two lots, one of which was kept at room temperature and the other at a constant temperature of 20° C. The only considerable difference in the results due to the difference in method is that the number of sterile (*i.e.*, apparently smothered) berries was smaller during the season of 1917–18. In this respect the results of the second year are more reliable. Storing the berries at a constant temperature (20° C.) apparently changed the results little, which indicates that, in so far as concerns the kinds and abundance of the fungi which developed, those obtained in 1916 with the berries stored at room temperature are satisfactory.

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[1] The work summarized in this paper forms a part of the study of the spoilage of cranberries after harvest, which is being carried on jointly by the Massachusetts Agricultural Experiment Station and the United States Department of Agriculture. For further information on this general subject see Mass. Agr. Exp. Sta. Buls. Nos. 168 and 180, and U. S. Dept. Agr. Bul. No. 714.

[2] The fungi were all cultured and identified by Rudolph, whose enlistment in the navy late in 1917 prevented the completion of the work planned for that season. Mr. Rudolph was at that time scientific assistant, fruit disease investigations, Bureau of Plant Industry.

More than a dozen species of fungi occurred in the cultures made during the first season. Of these, seven are known to be more or less important causes of decay of cranberries in storage, namely, *Guignardia vaccinii* Shear (early rot); *Glomerella cingulata vaccinii* Shear (bitter rot); *Fusicoccum putrefaciens* Shear (end rot); *Ceuthospora lunata* Shear (black rot); *Sporonema oxycocci* Shear (ripe rot); *Penicillium* spp. (soft rot); and *Phomopsis* sp. Table I shows the relative prevalence of the four most abundant of these fungi in terms of the percentage of the total number of spoiled berries. Occasionally the percentages recorded total more than 100, an apparent discrepancy which is accounted for by the fact that two or more fungi frequently develop from a single berry.

TABLE I. — *Most Important Fungi causing Storage Rot of Cranberries at Massachusetts State Experiment Bog, East Wareham, 1916.*

[Figures indicate per cent of total spoiled berries infected with each fungus.]

STORAGE PERIOD.	GLOMERELLA.		PHOMOPSIS.		SPORONEMA.		FUSICOCCUM.		STERILE.	
	Blacks.	Howes.	Blacks.	Howes.	Blacks.	Howes.	Blacks.	Howes.	Blacks.	Howes.
Sept. 27–Oct. 11,	3	–	63	–	3	–	20	–	13	–
Oct. 14–18,	30	30	37	40	3	0	7	3	17	23
Oct. 11–25,	7	47	40	20	3	3	7	17	40	17
Oct. 18–Nov. 1,	15	47	36	7	15	0	33	30	0	13
Oct. 25–Nov. 8,	0	13	40	0	3	0	13	53	47	23
Nov. 1–15,	0	6	13	0	3	0	47	60	37	33
Nov. 8–22,	3	20	17	7	0	0	53	47	20	23
Nov. 16–30,	0	27	13	3	0	0	47	50	43	16
Nov. 23–Dec. 7,	0	3	17	3	0	0	40	70	47	20
Nov. 29–Dec. 13,	0	13	13	7	7	0	47	20	50	56
Dec. 6–20,	0	7	7	7	0	0	46	50	37	27
Dec. 13–27,	0	0	10	3	0	0	33	30	57	60

Comparing first the fungi found in the two varieties during this season it will be noted that Sporonema is much more abundant on the Early Blacks, though even on this variety it is not of very great importance. Phomopsis is considerably more common on the Early Blacks and Glomerella on the Howes. Fusicoccum (end rot) is an important storage rot on both varieties. Such differences as have been noted between the varieties may well be accidental. Howes usually bloom three to eight days later than Early Blacks, and thus might be in a condition of susceptibility to certain fungi at different times from the Blacks.

TABLE II. — *Cranberry Blooming Period at the Station Bog, East Wareham, Mass.*

YEAR.	Early Black.	Howes.
1913,	June 20–July 14	July 1–July 18
1914,	June 26–July 20	June 30–July 23
1915,	July 1–July 20	July 9–July 26
1916,	July 1–July 18	July 5–July 22
1917,	July 3–July 23	July 9–July 28
1918,	June 25–July 12	June 28–July 15

Certainly it would be unsafe to assume, without very extensive study, that either variety was especially susceptible to a given fungus.

The relative importance of the various fungi at different times during the storage season is most easily seen from the graphs, Figs. 1 and 2. In both varieties Phomopsis and Glomerella are most abundant early in the storage season, and become gradually less important. Fusicoccum, on the other hand, is relatively scarce early in the season, and becomes very much more abundant as the season advances, so that after the 1st of November end rot is more important than all the other rots combined. That this relation does not always hold is proven by the records of the succeeding year, but it seems probable that, in Massachusetts, end rot is the most serious cause of decay in stored cranberries during the latter part of the season. End rot in early stages can be identified on the fruit with a fair degree of certainty by careful observers, and its importance as a cause of loss in stored fruit has been emphasized by Mr. H. S. Griffith, chairman of the inspectors of the New England Cranberry Sales Company, in his report for 1919 (page 21).

The results of the second year's work as given in Table III show interesting resemblances to those of the previous year.

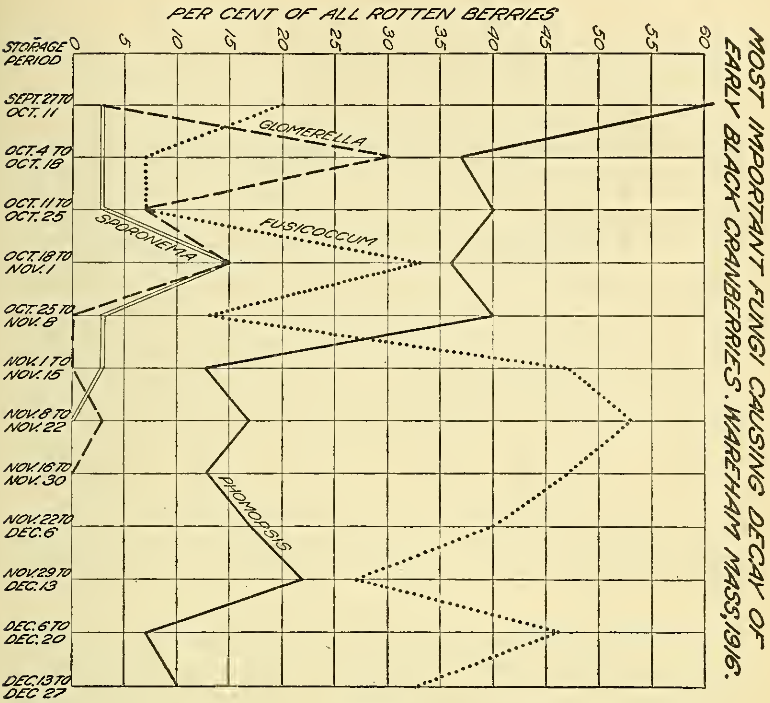
PER CENT OF ALL ROTTEN BERRIES
0
5
10
15
20
25
30
35
40
45
50
55
60
STORAGE PERIOD
SEPT. 27 TO OCT. 11
OCT. 4 TO OCT. 18
OCT. 11 TO OCT. 25
OCT. 18 TO NOV. 1
OCT. 25 TO NOV. 8
NOV. 1 TO NOV. 15
NOV. 8 TO NOV. 22
NOV. 16 TO NOV. 30
NOV. 22 TO DEC. 6
NOV. 29 TO DEC. 13
DEC. 6 TO DEC. 20
DEC. 13 TO DEC 27
GLOMERELLA
FUSICOCCUM
SPORONEMA
PHOMOPSIS
MOST IMPORTANT FUNGI CAUSING DECAY OF EARLY BLACK CRANBERRIES. WAREHAM MASS, 1916.

FIG. 1.

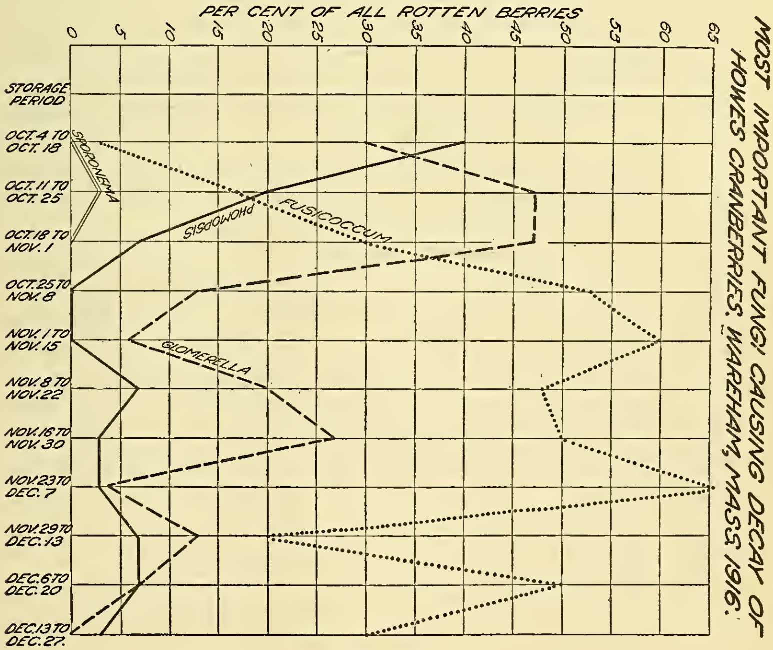
PER CENT OF ALL ROTTEN BERRIES
0
5
10
15
20
25
30
35
40
45
50
55
60
65
STORAGE PERIOD
OCT. 4 TO OCT. 18
OCT. 11 TO OCT. 25
OCT. 18 TO NOV. 1
OCT. 25 TO NOV. 8
NOV. 1 TO NOV. 15
NOV. 8 TO NOV. 22
NOV. 16 TO NOV. 30
NOV. 23 TO DEC. 7
NOV. 29 TO DEC. 13
DEC. 6 TO DEC. 20
DEC. 13 TO DEC. 27.
SPORONEMA
PHOMOPSIS
FUSICOCCUM
GLOMERELLA
MOST IMPORTANT FUNGI CAUSING DECAY OF HOWES CRANBERRIES. WAREHAM, MASS. 1916.

FIG. 2.

TABLE III. — *Most Important Fungi causing Storage Rot of Cranberries at Massachusetts State Experiment Bog, East Wareham, 1917.*

[Figures indicate per cent of total spoiled berries infected with each.]

STORAGE PERIOD.	Storage Temperature (Degree C.).	GLOMERELLA.		PHOMOPSIS.		SPORONEMA.		FUSICOCCUM.		STERILE.	
		Blacks.	Howes.	Blacks.	Howes.	Blacks.	Howes.	Blacks.	Howes.	Blacks.	Howes.
Before storage, . .	–	61	89	5	5	22	4	9	1	11	4
Storage ended Oct. 15,	20	12	76	30	3	15	0	21	3	15	7
	13[1]	23	88	40	4	20	0	13	1	11	8
Storage ended Nov. 12,	20	12	82	32	2	0	0	40	4	20	10
	18[1]	12	51	18	6	8	6	58	12	6	24
Storage ended, . .	20	2	43	10	3	3	3	67	18	9	23
	5[1]	1	31	3	6	2	3	58	36	11	10

[1] Estimated from outside temperature and from temperature of same room during the same periods of the previous year.

As in 1916 Sporonema is the least important of the four, and is found chiefly on the Early Blacks. Phomopsis is again more common on the Early Blacks, and Glomerella on the Howes; indeed, the contrast is more striking in 1917 than in 1916. During both years Phomopsis and Glomerella are more abundant early in the season, while Fusicoccum is rare early in the storage period and becomes more abundant later. The most unusual feature presented by the results is the very great abundance of Glomerella on Howes during 1917, and the relative scarcity of Fusicoccum.

So far as is now known infection by the various fungi causing decay of cranberries generally occurs before the berries are picked. That the development of the fungus is often delayed for some time is evident from the data here published, when it is recalled that in every case only apparently sound fruit was used for the storage test. The conditions necessary for the further development of a fungus already in the fruit or attached to the outer epidermis as a spore or appressorium are not yet determined. That it is not entirely a matter of condition of the berry is apparent from the fact that end rot, for example, becomes abundant on the Howes as soon as on the riper Early Blacks; and that it is not a matter of temperature appears (see Table III) from the fact that berries kept at 20° C. showed no marked difference in this respect from berries kept at lower temperatures.

BULLETIN No. 199.

DEPARTMENT OF POULTRY HUSBANDRY.

BROODINESS IN DOMESTIC FOWL.

DATA CONCERNING ITS INHERITANCE IN THE RHODE ISLAND RED BREED.

BY H. D. GOODALE, RUBY SANBORN AND DONALD WHITE.

Introduction.

Broodiness, as pointed out by Herrick (1907a, 1907b), is one phase of a recurring cyclical process in birds. In the domestic fowl when kept primarily for egg production, the instinct is not allowed to run its normal course, but is checked by suitable means in its initial objective stages. Some individuals, however, never exhibit the instinct. In this study of the inheritance of broodiness two categories of birds may be recognized, viz., those that exhibit the initial stages of broodiness, which are promptly checked, and those that do not exhibit any signs of broodiness. Broodiness is intimately connected with egg production, and, other factors being equal, its presence or absence determines the number of eggs laid, since, as shown later, its presence tends towards decreased production. A knowledge of its inheritance should show the steps necessary for its complete elimination from a flock.

The character, moreover, is not a superficial and unimportant one, but is a well-defined characteristic of the class Aves, and is essential for the survival of every species in the class. If the instinct were lost in a state of nature, without being replaced by some compensating mechanism,[1] the race would become extinct. In nature selection is constantly directed in favor of the character, since those individuals that lack it will leave no progeny, yet among domestic fowl we find entire races in which the character is lacking.

Poultrymen recognize both broody and non-broody races. The American breeds, *i.e.*, Plymouth Rocks, Rhode Island Reds and Wyandottes, and the Asiatics, *i.e.*, Langshans, Cochins and Brahmas, may be cited as examples of the former, while Hamburgs and Campines, and the Mediterranean breeds, *i.e.*, Leghorns, Spanish and Anconas, furnish examples of the latter. The distinction is based on the proportion between broody and non-broody individuals in each race, for some non-broody individuals occur among the broody races, while records are lacking to show that broody individuals are entirely absent from any of the non-broody races. The Leghorns are commonly regarded as a non-broody race, but as shown in Table VI, taken from the report of the fifth laying contest at Storrs (Kirkpatrick and Card, 1917), a considerable number become broody. It is a matter of common knowledge among poultry keepers that among the broody races there are considerable differences, some races, of which the Rhode Island Reds are an example, having an intense development of broodiness compared with others, such as the Barred Plymouth Rocks, in which the amount of broodiness is relatively slight.

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[1] It is well known, of course, that the American cowbird and the European cuckoo have developed a compensating mechanism.

There are few published reports on the character in the domestic fowl, though there is, of course, a considerable amount of matter scattered through the poultry literature, in which broodiness is mentioned in a more or less general way, but which is of no importance from the standpoint of this paper. Both Bateson's (1902) and Hurst's (1905) data showed that in a cross between a broody and non-broody race, broodiness was dominant, but they have published no further observations. Pearl (1914) has published certain data relating to broodiness, with which in general our data agree. A repetition of the same sort of material is unnecessary here. His methods of collecting the data and of handling the broody birds also are essentially the same as our practices in these respects. In general, our experience with this instinct agrees with his, except that there are two points for which different interpretations may be presented. On page 285 (*loc. cit.*) he makes this statement: "It appears to be the case that in the domestic fowl the brooding instinct has to a very large degree disappeared along with the fact of domestication." Evidently this author had not encountered a strain like our Rhode Island Reds, for such a statement would be impossible after an experience with such a strain. In the second place, we entertain some doubt as to the advisability of measuring the intensity of broodiness by the length of the non-productive period associated with the objective symptoms of broodiness (*loc. cit.*, page 273), because, while the cessation of egg production coincides in nearly every instance with the onset of objective symptoms, the resumption of production is often delayed by other factors, among which may be noted the innate capacity for egg production and readiness to molt. In regard to its effect on egg production, Goodale (1918) makes the statement that the ratio between the egg production prior to the first broody period and that subsequent thereto is about 100:60.[1] Gerhartz (1914) has studied the metabolism of the broody hen in connection with his studies on the metabolism of the laying hen.

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[1] The data on which this statement is based are given for the first time in Table VIII.

The Material and its Treatment.

The materials for the present study of the inheritance of broodiness are the pullet-year trap-nest records of the flock of Rhode Island Reds, bred at this station from 1913 to 1917, primarily to furnish data on the inheritance of fecundity. The usefulness of these data is limited in one important respect, since, as discussed in the section on variation, a year's record is not long enough to determine a hen's capacity for becoming broody. Limitations in housing capacity and labor have hitherto prevented the retention of non-broodies as long as was desirable. In the handling of the data, therefore, we have classified birds as broody or non-broody on the basis of the pullet-year records only, even though on this basis the non-broody class will contain more birds than it should. However, the theories of the inheritance of broodiness to which we have been led could not be substantiated from the available data, even if the difficulty under discussion were removed.

Recognition and Treatment of Broody Birds.

The recognition of a broody period is an easy matter with slight experience. The onset of broodiness is usually sudden. On the last visit to the trap nests late in the afternoon one or more birds are found that are very much disinclined to leave the nest. If they cluck and ruffle their feathers the diagnosis is certain, and the birds are removed to the broody coop to be "broken up." Sometimes part of the symptoms are lacking. In case of doubt the bird is merely removed from the nest. By the following afternoon, if she is really broody, all symptoms are well manifest. Mistakes are not easily made.

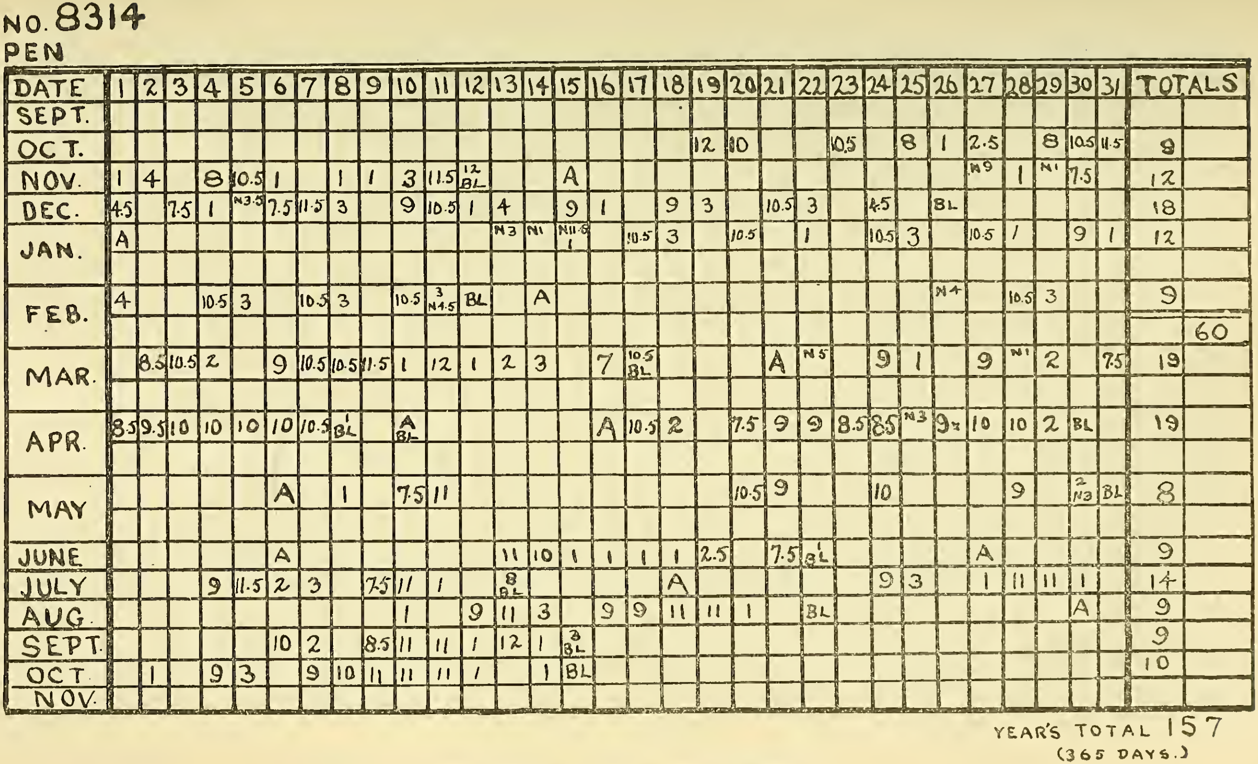
The broody coop in which the broody hens are confined, in order to prevent the instinct from running its normal course, is a box with slatted sides, top and bottom. The routine practice in dealing with broodies is to place all the broodies found in each pen in one of these coops. The same coop also receives the broodies on each of the two days following. Three days later the entire lot is released as a unit. Thus, the birds are confined from three to six days each, a period which is sufficient for the majority to "recover from the attack." A few, however, require a longer period of confinement. The confined broody individuals are supplied *ad libitum* with the same sort of food and water supplied the rest of the flock.

A bird must, as a rule, be classified either as broody or not broody, though in a few rare instances birds have exhibited a part of the broody symptoms only, as, for example, when a hen clucks and ruffles her feathers, but does not remain on the nest continuously, nor cease laying.

Variation in Amount of Broodiness.

A bird once broody may exhibit the character in various degrees which can be classified under two heads, — first, variation in the number of times a bird becomes broody in a period of given duration, usually the laying year; and second, variation in length and intensity of the individual broody periods. The latter is the less important of the two, for the length of time required by the vast majority of birds to "recover" from the attack is of comparatively small importance. To be sure, some birds take double the time that others require in "recovering," but it is an extreme case when more than a week is required, if no extraneous factors are present. Further, on forming a correlation table between number of days confined and subsequent egg production, it became evident that the coefficient of correlation (though not calculated) was so small that no relationship of importance existed between the subject and relative. The large factor in variability in broodiness is found in the variation in the number of times the broody cycle is repeated, as is shown later on.

Four sample egg records are shown here to illustrate individual variations in amount of broodiness. A numeral in a square indicates the hour at which an egg was collected; B. L., broody and placed in broody coop; A, released from broody coop; N, associated with a numeral, means that the bird visited the nest, but did not lay.

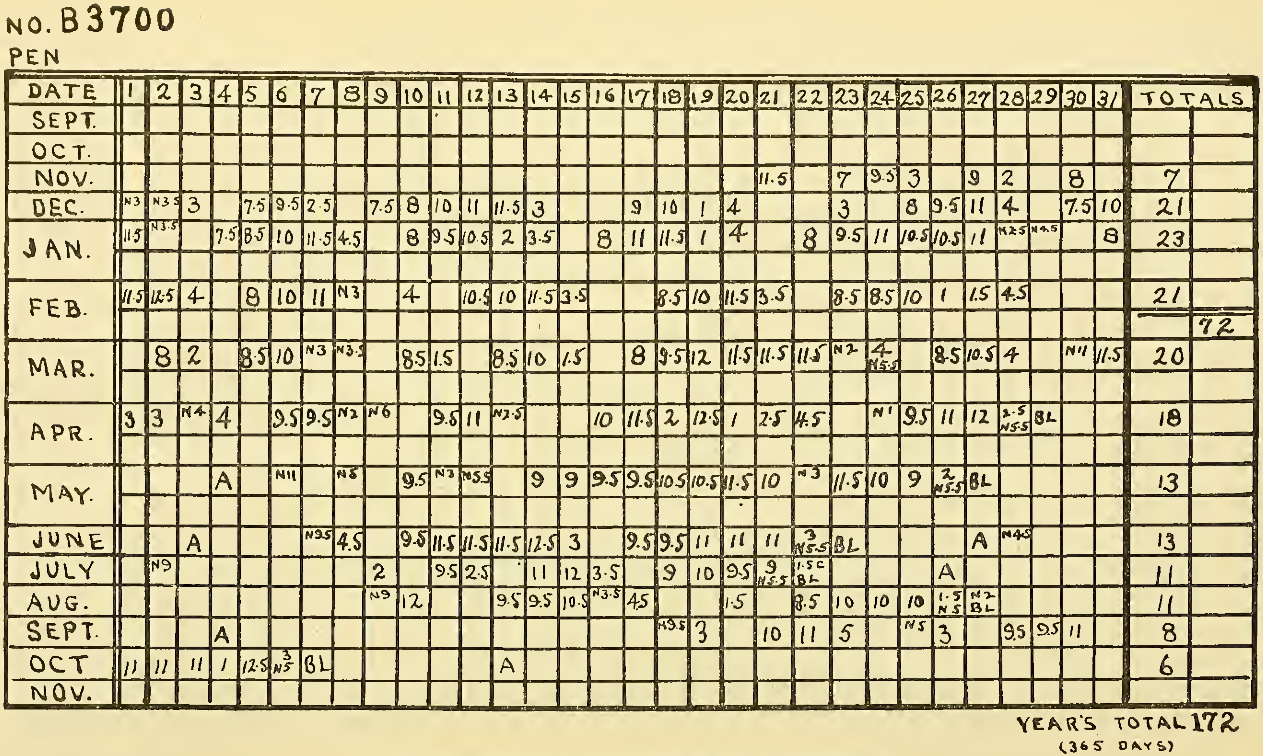


No. 8314
PEN

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTALS	
SEPT.																																	
OCT.																			12	10			10.5		8	1	2.5		8	10.5	11.5	9	
NOV.	1	4		8	10.5	1		1	1	3	11.5	12 BL			A												N9	1	N1	7.5		12	
DEC.	4.5		7.5	1	N3.5	7.5	11.5	3		9	10.5	1	4		9	1		9	3		10.5	3		4.5		BL						18	
JAN.	A												N3	N1	N11.5 1		10.5	3		10.5		1		10.5	3		10.5	1		9	1	12	
FEB.	4			10.5	3		10.5	3		10.5	3 N4.5	BL		A												N4		10.5	3			9	
																																	60
MAR.		8.5	10.5	2		9	10.5	10.5	11.5	1	12	1	2	3		7	10.5 BL				A	N5		9	1		9	N1	2		7.5	19	
APR.	8.5	9.5	10	10	10	10	10.5	1 BL		A BL						A	10.5	2		7.5	9	9	8.5	8.5	N3	9x	10	10	2	BL		19	
MAY						A		1		7.5	11									10.5	9			10				9		2 N3	BL	8	
JUNE						A							11	10	1	1	1	1	2.5		7.5	1 BL					A					9	
JULY				9	11.5	2	3		7.5	11	1		8 BL					A						9	3		1	11	11	1		14	
AUG.										1		9	11	3		9	9	11	11	1		BL								A		9	
SEPT.						10	2		8.5	11	11	1	12	1	3 BL																	9	
OCT.		1		9	3		9	10	11	11	11	1		1	BL																	10	
NOV.																																	

YEAR'S TOTAL 157
(365 DAYS.)

FIG. 1.—Egg record of a very broody individual.



NO. B3700
PEN

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTALS	
SEPT.																																	
OCT.																																	
NOV.																					11.5		7	9.5	3		9	2		8		7	
DEC.	N3	N3.5	3		7.5	9.5	2.5		7.5	8	10	11	11.5	3			9	10	1	4			3		8	9.5	11	4		7.5	10	21	
JAN.	11.5	N3.5		7.5	8.5	10	11.5	4.5		8	9.5	10.5	2	3.5		8	11	11.5	1	4		8	9.5	11	10.5	10.5	11	N2.5	N4.5		8	23	
FEB.	11.5	12.5	4		8	10	11	N3		4		10.5	10	11.5	3.5			8.5	10	11.5	3.5		8.5	8.5	10	1	1.5	4.5				21	
																																	72
MAR.		8	2		8.5	10	N3	N3.5		8.5	1.5		8.5	10	1.5		8	9.5	12	11.5	11.5	11.5	N2	4 N5.5		8.5	10.5	4		N11	11.5	20	
APR.	3	3	N4	4		9.5	9.5	N2	N6		9.5	11	N2.5			10	11.5	2	12.5	1	2.5	4.5		N1	9.5	11	12	2.5 N5.5	BL			18	
MAY.				A		N11		N5		9.5	N3	N5.5		9	9	9.5	9.5	10.5	10.5	11.5	10	N3	11.5	10	9	2 N5.5	BL					13	
JUNE			A				N9.5	4.5		9.5	11.5	11.5	11.5	12.5	3		9.5	9.5	11	11	11	3 N5.5	BL				A	N4.5				13	
JULY		N9							2		9.5	2.5		11	12	3.5		9	10	9.5	9 N5.5	1.5C BL				A						11	
AUG.									N9	12			9.5	9.5	10.5	N3.5	45			1.5		8.5	10	10	10	1.5 NS	N2 BL					11	
SEPT.				A														N9.5	3		10	11	5		NS	3		9.5	9.5	11		8	
OCT	11	11	11	1	12.5	3 N5	BL						A																			6	
NOV.																																	

YEAR'S TOTAL 172
(365 DAYS)

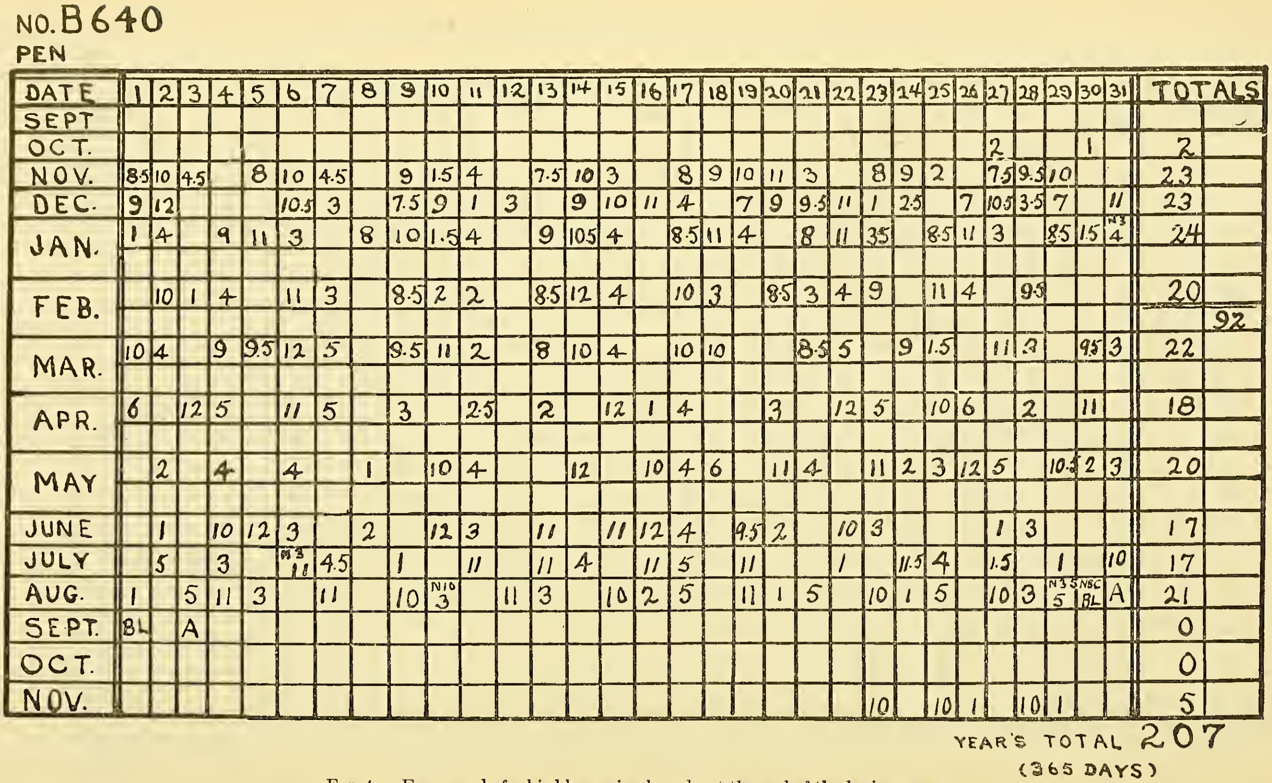
FIG. 2.—Egg record of a bird becoming broody about midseason.

NO. B 3226
PEN

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTALS	
SEPT.																																	
OCT.																																	
NOV.										N3												N10 N11.5 1.5		8.5	9	3		7.5	8.5	11		7	
DEC.	11	11	1.5	3		8.5	10	9.5	10.5	1.5		8	10	2		8	9	10	11	11	11	2	1	4		N4	8.5		10.5	3		24	
JAN.	8.5	10	1.5	3.5		8	10	11.5	N11 4		9.5	10.5	2	4.5		8	9.5	10	1	4		8	N1	11	3		8	9	9	11	11	25	
FEB.	1	4.5		8	9	10	11	11.5	1.5	2.5	5		N8.5	10	1	3.5		8.5	1	2		8	10.5	3.5		8.5	11.5	3.5				22	
																																	78
MAR.		8	10.5	10.5	1.5	3		8	10.5	11.5	N3		8.5	N3.5			N1	2		7.5	10	11.5	11.5	11.5	12	1.5	1	1.6	5.5		9.5	21	
APR.	12	12	2	2	6		9.5	11.5	2.5	2	5.5		9.5	11.5	12.5	1.5			9.5	11	2.5	4.5		9.5	11	11	12	12	12.5	5		25	
MAY		9.5	N12	12.5	3	3.5	N6		12.5 N6	4.5 N5.5	BL						A N6.5					N8	N8		9	10.5	N8 12	3.5	N4 6		9.5	12	
JUNE	11.5	12	2.5		N9.5	11 LO	12.5	4.5		11.5	3		11	5	N12.5	1	N9.5	12.5	N12.5	N9 N10.5 2		N9 N11 12.5	N9 N4	N9 N10.5 2	N12 3.5	N5	9.5	N9 N10.5 4.5	N9 N4	N9 10.5		19	
JULY	N12 2.5	N9 N6	9	11.5	3		9	N9 2	N9.5 N12 5.5	N9 N11.5	N9 11	12.5	5		10.5	1.5	5		11	3		11	3.5	N5	8	2	N4.5	9.5	2		9.5	22	
AUG.	1	3.5		9	11.5	5.5	N3	10.5	3		10.5	12	4.5	N3	9.5	2	4.5		11.5		N3.5	N2.5	11.5	4	N1	10	1.5		10.5	3.5	N1.5	20	
SEPT.	11.5	3.5 N5		10.5	3		11	5		11	5	N1	11	4.5		1.5																11	
OCT.					N11																											0	
NOV.																																	

YEAR'S TOTAL 208
(365 DAYS.)

FIG. 3.—Egg record of a bird becoming broody only once the first year, and that at midseason.



NO. B640
PEN

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTALS	
SEPT																																	
OCT.																											2			1		2	
NOV.	8.5	10	4.5		8	10	4.5		9	1.5	4		7.5	10	3		8	9	10	11	3		8	9	2		7.5	9.5	10			23	
DEC.	9	12				10.5	3		7.5	9	1	3		9	10	11	4		7	9	9.5	11	1	2.5		7	10.5	3.5	7		11	23	
JAN.	1	4		9	11	3		8	10	1.5	4		9	105	4		8.5	11	4		8	11	35		8.5	11	3		8.5	1.5	N3 4	24	
FEB.		10	1	4		11	3		8.5	2	2		8.5	12	4		10	3		8.5	3	4	9		11	4		9.5				20	92
MAR.	10	4		9	9.5	12	5		9.5	11	2		8	10	4		10	10			8.5	5		9	1.5		11	3		9.5	3	22	
APR.	6		12	5		11	5		3		2.5		2		12	1	4			3		12	5		10	6		2		11		18	
MAY		2		4		4		1		10	4			12		10	4	6		11	4		11	2	3	12	5		10.5	2	3	20	
JUNE		1		10	12	3		2		12	3		11		11	12	4		9.5	2		10	3				1	3				17	
JULY		5		3		N3 11	4.5		1		11		11	4		11	5		11			1		11.5	4		1.5		1		10	17	
AUG.	1		5	11	3		11		10	N10 3		11	3		10	2	5		11	1	5		10	1	5		10	3	N35 5	NBC BL	A	21	
SEPT.	BL		A																													0	
OCT.																																0	
NOV.																							10		10	1		10	1			5	

YEAR'S TOTAL 207
(365 DAYS)

FIG. 4.—Egg record of a bird becoming broody at the end of the laying year.

Figures 1, 2 and 4 are examples of variability in number of broody cycles. It will be observed that there is a period of production of variable length before the first broody period makes its appearance. This may come soon after production begins (Fig. 1), or may be delayed till near the end of the season (Fig. 4), or even till subsequent seasons. After the first broody period subsequent periods occur in fairly regular sequence, the cycle of broody, rest and production being repeated over and over. It is obvious, then, that the number of broody periods occurring during the first year will be determined in part by the time of year the first broody period occurs. After one broody period it becomes a question of the number of additional cycles that are added before a bird stops laying for the season. In the extreme case of Fig. 4, production was not resumed after the first broody period, which came late in the season.

In later years there has been much less regularity in the recurrence of the broody periods in that part of the flock bred specifically for increased egg production, but the parallelism does not necessarily mean that the latter has caused the former. It is noticeable that the broody periods are fewer in number and limited to the height of the broody season in many individuals, which afterward may become regular producers, without further evidence of broodiness in that season. For example, instances are quite common where a single broody period occurs in mid-season, and is followed by continuous production, as shown in Fig. 3. Sometimes there are two or even three such periods followed by continuous production. Occasionally some birds have broody periods occurring at rather irregular intervals.

When birds are kept through the second season it is found that some birds that did not become broody the first season may become broody at some point in the second season. One instance occurred where the bird did not become broody till the third season. Because of the physical limitations in the matter of plant equipment we are unable to give the exact percentage of birds not broody in their pullet year that became broody later on. We have, of course, the data for such birds as were kept over, but we do not believe it gives a fair picture of what will be found in large flocks. They are, however, fairly numerous. There is, moreover, some evidence that various lines behave unlike others in this respect. On the other hand, only four instances free from complications have occurred among our records of birds that were broody the first season but failed to become broody thereafter. It is clear that the pullet year is a good index of the presence of the broody instinct for those birds that actually become broody, but not as good an index for those that do not become broody.

This brief description of variation in amount of broodiness, together with the data given in Table VIII, is sufficient to give the reader a general idea of its nature. Further details are outside the scope of this paper.

Germinal Basis of Broodiness.

The normal or wild condition is the presence of broodiness, otherwise the race could not survive. Hence, any changes from the normal condition of those parts of the germ plasm which are responsible for the existence (as distinguished from amount) of broodiness will probably result in a failure in the appearance of the broody instinct. Broodiness may also, of course, fail to become manifest from non-genetic causes, and hence some genetically broody birds are recorded as non-broody. Non-broodiness, therefore, is a comprehensive term employed to describe the phænotypic condition resulting from several sorts of genetic differences. The situation is parallel, in certain respects, to that of eye color in Drosophila. Red eye is the normal or wild color. Changes in the germ plasm result in a host of other eye colors, which are all non-red. In like manner, from the genetic standpoint, all broody birds are presumably alike in their fundamental broody mechanism, except for the homozygous or heterozygous condition, and, of course, the presence of modifiers discussed in the next paragraph. Non-broody birds, on the other hand, may belong to quite different genotypes. It is, therefore, improbable that any one scheme can be applied to the inheritance of non-broodiness in domestic fowl. Indeed, the data given in Tables II and III indicate clearly that several types of non-broodies exist in the Rhode Island Reds. The presence of these types suggests that still different genetic types of non-broodies will be discovered in other breeds.

It seems clear on general grounds that a distinction must be made between the primary factors concerned with broodiness and modifying factors. The latter may act in various ways on the primary mechanism for the manifestation of broodiness, but they cannot act unless that mechanism is present. We may expect that such modifying factors will control the intensity of broodiness in either a plus or minus direction, and, extending this reasoning to its logical conclusion, such modifying factors may prevent entirely any manifestation of broodiness. Non-broodiness, therefore, may result from some genetic change in the secondary mechanism, as well as in the primary.

There are three possible sorts of matings (the male being treated as though capable of giving phænotypic expression to his genotypic constitution), viz., both parents may be broody, both non-broody, or one broody and the other non-broody. From each of these three possible matings there are three possible groupings of the female offspring, *i.e.*, (1) all may be broody, (2) all non-broody, and (3) part broody, part non-broody, as shown in Table I.

TABLE I. — *Kinds of Offspring expected from all Possible Kinds of Matings.*

PARENTS.	Offspring.
Both parents broody,	All broody. All non-broody.* Part broody, part non-broody.
Both parents non-broody,	All broody.* All non-broody. Part broody, part non-broody.
One parent broody, the other non-broody,	All broody. All non-broody.* Part broody, part non-broody.

Of the nine possible groupings between parents and offspring, six have been realized in our experience. Those marked with an asterisk (*) have not been realized. Two of the three unrealized possibilities should be realized eventually, and the third, all non-broody offspring from broody parents, is not expected, as is explained beyond.

The preceding table, as well as the ratios in which the offspring occur, Table II, does not agree with the assumption that broodiness is a simple Mendelian dominant and non-broodiness a simple recessive in all instances as Hurst (1905) supposed. If non-broodiness were a simple Mendelian recessive, then the son of a non-broody hen should throw either all non-broodies or half non-broodies when bred to non-broodies, but this does not always happen. Moreover, the establishment of a non-broody strain should have been a much simpler matter than it has proved.

TABLE II. — *A Comparison between Observed and Theoretical Ratios, assuming that Two Factors, A and C, must both be present in order that an Individual may become Broody.*

FATHER'S BAND NUMBER.	1915.							1916.								1917.							
	NUMBER OF MOTHERS.			OFFSPRING.				Father's Band Number.	NUMBER OF MOTHERS.			OFFSPRING.				Father's Band Number.	NUMBER OF MOTHERS.			OFFSPRING.			
				OBSERVED RATIO.		EXPECTED RATIO.						OBSERVED RATIO.		EXPECTED RATIO.						OBSERVED RATIO.		EXPECTED RATIO.	
	Non-broody.	Broody.	Total.	Non-broody.	Broody.	Non-broody.	Broody.		Non-broody.	Broody.	Total.	Non-broody.	Broody.	Non-broody.	Broody.		Non-broody.	Broody.	Total.	Non-broody.	Broody.	Non-broody.	Broody.
68,	1	3	4	0	9	0	9	274	0	2	2	0	8	0	8	3003	4	1	5	23	1	$22\frac{1}{8}$	$1\frac{7}{8}$
A143,	1	2	3	1	9	0	10	3617	0	5	5	6	24	$3\frac{1}{2}$	$26\frac{1}{2}$	5470	4	0	4	13	5	13	5
228,	0	3	3	0	5	0	5	4312	0	1	1	0	8	0	8	5581	0	1	1	0	4	0	4
269,	3	10	13	7	40	6	41	4354	1	4	5	5	32	2	35	7727	0	2	2	1	3	$\frac{3}{4}$	$3\frac{1}{4}$
270,	0	2	2	0	6	0	6	4378	0	4	4	6	22	$5\frac{1}{2}$	$22\frac{1}{2}$	7745	0	3	3	4	10	$2\frac{1}{2}$	$11\frac{1}{2}$
271,	0	4	4	2	15	$\frac{7}{8}$	$16\frac{1}{8}$	4723	0	6	6	15	59	$16\frac{7}{8}$	$57\frac{1}{8}$	7931	0	1	1	2	1	$1\frac{5}{16}$	$1\frac{11}{16}$
272,	0	1	1	0	2	0	2	4786	0	2	2	2	6	$\frac{7}{8}$	$7\frac{1}{8}$	8027	2	6	8	30	39	$27\frac{1}{2}$	$41\frac{1}{2}$
274,	4	5	9	0	43	0	43	4882	0	1	1	5	20	$6\frac{1}{4}$	$18\frac{3}{4}$	8095	1	3	4	3	4	$2\frac{13}{16}$	$4\frac{3}{16}$
A323,	0	1	1	0	1	0	1	5077	0	3	3	2	10	$2\frac{1}{4}$	$9\frac{3}{4}$	8097	0	5	5	21	22	$17\frac{1}{4}$	$25\frac{3}{4}$
619,	0	2	2	0	3	0	3	5240	0	1	1	0	7	0	7	8147	2	5	7	15	33	18	30
2313,	0	5	5	1	30	$\frac{7}{8}$	$30\frac{1}{8}$	5470	0	1	1	1	2	$1\frac{1}{2}$	$1\frac{1}{2}$	8217	0	3	3	0	9	0	9
2539,	0	1	1	0	1	0	1	5477	0	2	2	0	15	0	15	8422	1	2	3	7	4	$6\frac{1}{2}$	$4\frac{1}{2}$
2914,	1	2	3	2	7	$2\frac{7}{8}$	$6\frac{1}{8}$	5581	0	7	7	2	42	$1\frac{1}{2}$	$42\frac{1}{2}$	8528	1	5	6	27	32	$28\frac{1}{4}$	$30\frac{3}{4}$
3003,	4	1	5	11	3	$11\frac{3}{8}$	$2\frac{5}{8}$	5584	0	4	4	3	35	0	38	8761	0	4	4	9	15	$7\frac{5}{16}$	$16\frac{11}{16}$
3533,	0	4	4	1	11	$\frac{7}{16}$	$11\frac{9}{16}$	5642	1	0	1	0	2	0	2	9305	0	2	2	2	5	$1\frac{1}{2}$	$5\frac{1}{2}$
3617,	1	10	11	1	38	$1\frac{1}{4}$	$37\frac{3}{4}$	5776	0	1	1	0	8	0	8	9752	6	5	11	57	16	$48\frac{3}{8}$	$24\frac{5}{8}$
4128,	0	4	4	2	10	$1\frac{1}{2}$	$10\frac{1}{2}$	6265	0	3	3	1	19	0	20	–	–	–	–	–	–	–	–
4167,	3	4	7	5	52	$5\frac{1}{2}$	$51\frac{1}{2}$	6373	0	4	4	0	22	0	22	–	–	–	–	–	–	–	–
4265,	0	3	3	2	16	$2\frac{1}{2}$	$15\frac{1}{2}$	6781	1	3	4	14	24	$16\frac{3}{8}$	$21\frac{5}{8}$	–	–	–	–	–	–	–	–
Brown,	0	1	1	0	3	0	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
McLean,	0	4	4	1	13	0	14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Several factorial explanations of the observed ratios between broodies and non-broodies in the several families can be developed, but choice among such explanations cannot be made because of the small size of the individual families, *i.e.*, the offspring of a single mother. Nor are any of them of value save as working hypotheses. The one on which Table II is based is presented simply to show that a close agreement between theory and fact is possible, and this theory was chosen for presentation because it gives a slightly better agreement between observed and theoretical rations, with one partial exception, than the others. This theory assumes that the appearance of broodiness in Rhode Island Reds requires the simultaneous presence of two factors, designated A and C, in either homozygous or heterozygous condition. A better fit in the case of the partial exception can be secured by assuming that there is also a dominant factor (presumably a modifier) for non-broodiness, which may be designated as N. Non-broodies, therefore, may be of numerous genetic types, the homozygous forms being NNAACC, nnAAcc, nnaaCC; and nnaacc, where A and C, respectively, represent the factors (condition of germ plasm) necessary for broodiness. A broody bird, then, in homozygous form must be nnAACC. As shown by Table III, which gives the theoretical ratios expected on both the NNAACC and AACC theories, it will be seen that matings between birds of the same phænotype may give several different ratios, including those in which the proportions between broody and non-broody birds are reversed. Thus (NNAACC theory) broody x broody may give 3 broody to 1 non-broody, or it may give 1

TABLE III.—*The Theoretical Ratios resulting from Matings of Different Types, arranged by Ratios.*

[A ratio appears only once under its respective theory.]

PARENTS.	NNAACC THEORY.		AACC THEORY.	
	PROGENY.		PROGENY.	
	Non-broody.	Broody.	Non-broody.	Broody.
Broody × broody,	7	9	7	9
Non-broody × non-broody,	55 29 15 64	9 3 1 0	16	0
Broody × non-broody,	23	9	5	3
Broody × broody, broody × non-broody,	0 1	64 3	1	3
Broody × non-broody, non-broody × non-broody.	1 13 7	1 3 1	1 3	1 1
Broody × broody, broody × non-broody, non-broody × non-broody.	5 3	3 1	0	16

broody to 3 non-broody, exactly reversing the ratio, as has occurred in the detailed data from which Table II was compiled. It should be stated that while families showing the extreme ratio of 15 non-broody to 1 broody have not been encountered, several instances of the 7:1 ratio have been observed.

The only evidence at present available in support of either of these schemes is furnished by the ratios between the broody and non-broody members of the several families (Table II). N, if it represents a real condition of the germ plasm, occurs relatively infrequently in the flock at present. Practically all the observed ratios, except the partial exception mentioned, can be accounted for if N is omitted.

It is also possible to modify the AACC theory, by assuming that A is sex linked, though no evidence of sex linkage other than an agreement between the observed and theoretical ratios has been noted. Doubtless other schemes could be devised that would also account for the ratios.

Although the ratios themselves could perhaps be explained as chance deviations from monohybrid ratios (though this is doubtful in some instances), or as the result of errors of classification of individuals through failure to manifest the genotypic condition phænotypically, the moment lines of descent are established it becomes clear that a monohybrid explanation does not fit the facts. The data have been worked over in an attempt to apply the monohybrid scheme, *i.e.*, broodiness due to a single dominant factor, but without success. See, for example, the history of male No. 3003 and his offspring, page 107.

In order to establish the existence of any of the schemes under discussion certain results of critical importance must be obtained. Thus, the discovery of a family consisting of all non-broody offspring from the mating between a non-broody and a broody is required to demonstrate the presence of a dominant factor for non-broodiness, while a mating between two non-broody birds that gives all broodies is required as proof of the AACC theory (or a theory of the same order). The ratios at hand indicate the possibility that several genetic types of non-broodies coexist in our strain. One possibility only seems to be excluded if the schemes outlined represent the facts, for one need never expect to find a pair of broody birds that produces all non-broody offspring, because such a result would mean two distinct types of broodies which mutually inhibit each other.

Modifying Factors for Broodiness.

The possibility that the non-broodies dealt with in these experiments are not due to changes in the primary genes concerned with broodiness, but are due to changes in modifying genes, cannot be excluded. As we have worked over the records, the impression has been strong that we are not dealing with a real absence of broodiness so much as with delay in the appearance of broodiness. Unfortunately the present data are inadequate to settle this point. Nor is it likely that we shall have suitable data in the near future, because the somatic manifestations of broodiness, *i.e.*, the number of times a bird becomes broody as well as the ease with which she is broken up, vary considerably, as already described. Since the chief reason for this variability is found in the number of times a bird becomes broody, which in turn is so thoroughly interwoven with egg production, the same practical difficulties, *i.e.*, disease control, that at present prevent a complete analysis of the inheritance of fecundity also prevent the determination of the hereditary factors involved in degree of broodiness.

THE PRODUCTION OF A STRAIN OF LOW DEGREE OF BROODINESS THROUGH SELECTION.

Two lines of selection have been under way, — one for the elimination of broodiness, the other for its development to a high degree, equal to or greater than that observed in the case of Fig. 1. Because most of our facilities were needed in other directions, little has been done with the plus line beyond its maintenance. The minus line, however, has been closely involved with the problem of securing increased egg production, since absence of broodiness tends toward higher production, other things being equal. Until 1917 this line had been also carried on in a very small way, the general policy being to mate the son of a non-broody bird to non-broodies, on the hypothesis that broodiness is a simple Mendelian dominant, and non-broodiness a recessive. As a result of the early matings a male was obtained that appeared to be a homozygous recessive, since he threw no broodies from non-broody mothers. In 1917 this male, No. 3003, with his son, No. 5470 out of a non-broody hen, and grandson, No. 9752 (mother broody once in her third year), also supposed to be homozygous recessives, were mated to all the non-broody hens available. Some of these, however, became broody the second year. The results of the experiment, given in Tables IV and V, show that non-broodiness is not always a simple Mendelian recessive, since the son and grandson failed to breed true, even with those birds that never became broody. This

TABLE IV. — *The Progeny of Three Supposedly Non-broody Males distributed according to their Mother's Broody History.*

MALE.	MOTHERS NOT BROODY.			MOTHERS KNOWN TO BE BROODY AFTER PULLET YEAR.			MOTHERS BROODY IN PULLET YEAR.		
	Number of Mothers.	Daughters not Broody.	Daughters Broody.	Number of Mothers.	Daughters not Broody.	Daughters Broody.	Number of Mothers.	Daughters not Broody.	Daughters Broody.
No. 3003, ...	4	19	0	–	–	–	1	4	1
No. 5470 (son of No. 3003),	3	9	1	1	4	4	–	–	–
No. 9752 (son of No. 5470),	6	27	9	1	1	0	4	29	7

TABLE V. — *"Non-broody" Lines, 1917–18.*

[Daughters of males No. 3003, No. 5470 and No. 9752.]

	Number of Daughters.	DAUGHTERS NOT BROODY.		DAUGHTERS BROODY ONCE.		DAUGHTERS BROODY MORE THAN ONCE.		TOTAL BROODY DAUGHTERS.	
		Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
Mothers not broody in pullet year.	72	58	80.55	9	12.50	5	6.94	14	19.44
Mothers broody once in pullet year.	34	28	82.35	1	2.94	5	14.71	6	17.65
Totals, . . .	106	86	81.13	10	9.43	10	9.43	20	18.87

conclusion is supported by the ratios observed in other matings which have already been commented upon. However, the amount of broodiness in the first laying year is much reduced compared with the flock from which it originated, the data on this point being given in Table VII, Table VIII, item 4, and Table IX. A comparison with the published results of the laying contest at the Connecticut Agricultural Experiment Station shows that our foundation stock had broodiness developed to a higher degree than any of the breeds studied at Storrs, and that our non-broody

TABLE VI. — *Broodiness in the Several Breeds at the Storrs Contest of 1915–16, compared with Three Flocks at the Massachusetts Agricultural Experiment Station.*

BREEDS.	Number of Birds.	BROODY.		Average number of Times Broody per Broody Hen.	Average Number of Times Broody for All Birds in Flock.	Average Number of Days in Broody Period.	Average Number of Days spent in Broodiness by each Broody Hen.	Average Number of Days spent in Broodiness per Hen, per Year, all Birds included.
		Number.	Per Cent.					
Storrs.								
Plymouth Rocks, .	151	67	44.4	2.8	1.2	21.2	59.9	26.6
Wyandottes, . .	151	87	57.6	2.5	1.4	19.4	47.6	27.4
Rhode Island Reds, .	183	120	65.6	2.8	1.8	21.3	60.2	39.5
White Leghorns, .	315	43	13.6	1.3	.2	22.7	29.6	4.0
Massachusetts.								
Rhode Island Reds, 1912–13.	125	112	89.6	4.4	3.9	19.7	74.8	65.8
Rhode Island Reds, 1913–14.	78	71	91.0	5.4	4.9	16.3	78.8	68.7
Rhode Island Reds, 1917–18, "non-broody" line.	106	20	18.9	1.9	.4	20.9	37.0	10.6

TABLE VII. — *Number and Per Cent of Birds Broody and not Broody in Pullet Year in Three Flocks of Rhode Island Reds.*

DATE.	Total Birds.	BROODY.		NOT BROODY.	
		Number.	Per Cent.	Number.	Per Cent.
1912–13, ...	125	112	89.60	13	10.40
1913–14, ...	78	71	91.03	7	8.97
1917–18, ...	106	20	18.87	86	81.13

lines, derived from this extremely broody stock, exhibited a low degree of broodiness surpassed only by the Leghorns (Table VI). The most significant data on this point are given in the third and last columns of Table VI. Table VII shows the relation between the number of broody birds and those not broody for the flocks of 1912–13, 1913–14 and 1917–18. The flock of 1912–13 was the foundation stock.

Tables VIII and X give a further comparison between the broody birds of the flocks of 1913–14 and 1917–18.

TABLE VIII. — *Statistical Constants for Various Broody Characters for the Flock of 1913–14, and the Non-broody Flock of 1917–18.*

		NUMBER OF INSTANCES OR INDIVIDUALS.		MEAN.		STANDARD DEVIATION.		COEFFICIENT OF VARIATION.	
		1913-14.	1917-18.	1913-14.	1917-18.	1913-14.	1917-18.	1913-14.	1917-18.
1	Number of broody periods per individual.	71	20	5.39±0.23	1.90±0.17	2.87±0.16	1.14±0.12	53.24±3.77	59.78±8.35
2	Length of broody periods (days), . .	327	34	16.28±0.34	20.91±0.95	9.04±0.24	8.22±0.67	55.60±1.85	39.32±3.68
3	Amount of broodiness in each individual (broodies only) (days).	68	20	78.84±4.03	37.00±3.63	49.27±2.85	24.06±2.57	71.68±5.90	65.02±9.42
4	Amount of broodiness in each individual (entire flock) (days).	78	106	68.73±3.28	10.63±1.08	42.95±2.32	16.46±0.76	62.49±4.50	154.83±17.27
5	Days in initial laying period, ...	71	20	118.67±4.23	170.50±8.42	52.82±2.99	55.86±5.96	44.51±2.98	32.76± 3.85
6	Eggs in initial laying period, ...	71	20	80.64±2.85	101.50±3.84	35.66±2.02	25.48±2.72	44.22±2.95	25.10±2.84
7	Per cent production in initial laying period.	71	20	67.89±0.99	61.00±1.68	12.38±0.70	11.17±1.19	18.24±1.07	18.31± 2.02
8	Days in each laying period, ...	327	34	18.84±0.40	36.85±2.98	10.85±0.29	25.80±2.11	57.60±1.96	70.00± 8.06
9	Eggs in each laying period, ...	327	34	13.96±0.19	21.26±1.52	5.21±0.14	13.12±1.07	37.32±1.11	61.72± 6.70
10	Per cent production in each laying period,	327	34	78.41±0.53	64.91±3.09	14.24±0.38	26.70±2.18	18.16±0.49	41.13± 3.89
11	Time spent in laying periods annually by each individual (days).	68	20	90.75	62.75	–[1]	–[1]	–[2]	–[3]
12	Average length of broody cycle (days), .	327	34	35.02±0.56	57.71±2.98	15.15±0.40	25.72±2.10	43.26±1.34	44.57± 4.31
13	Per cent production in broody cycle, .	327	34	41.50±0.43	35.94±1.54	11.55±0.30	13.29±1.09	27.83±0.79	36.98±3.41

[1] Standard deviation not calculated.

[2] Range 9–188.

[3] Range 16–114.

DEFINITION OF TERMS USED IN TABLE VIII.

2. In reckoning the number of days in a broody period the first day without production is taken as the first broody day, while the last day counted is the day before production begins again. The object here is to measure the length of the non-productive period originating with broodiness, but not the intensity of broodiness itself. This definition includes instances in which the resumption of production is delayed long after its normal time because of the interference of factors not concerned with broodiness. Some limitation to the number of days included in the non-productive period is desirable, but the only one employed thus far is the exclusion of broody periods that end the annual cycle of production, and whose length cannot be ascertained.

5, 6, 7. The initial laying period begins with the first egg laid, and ends with the last egg laid before the first broody period.

8, 9, 10. A laying period begins with the first egg laid after a broody period, and ends with the last egg laid before the subsequent broody period.

12, 13. A broody cycle is defined as a broody period plus the following laying period. The incomplete cycles formed by a terminal broody period are rejected in calculating the constants. It is, of course, possible to treat the broody cycle somewhat differently, by defining it as a laying period plus the subsequent broody period. Biometrical constants were calculated for each method of treatment, but since the results proved to be essentially the same, if the initial cycle is omitted, only one set of constants is given in the table.

Constants differing slightly from those given in the table are obtained, if, instead of employing each instance separately in the calculations, the average for each individual bird is employed. Whether the instance or the average for each individual bird should be used in calculating the constants depends on which one occupies the center of interest, but whichever method is used, the primary purpose for which this table is presented is not affected. The inconsistencies in the number of individuals occur because it is often possible to determine a character in one individual but not in another. Thus, every bird that becomes broody can be counted, but if a bird becomes broody but once, and does not lay again until the following year, the length of her broody period cannot be measured, and so is omitted in calculating the constants.

Taking the means (Table VIII) as the basis of comparison, it is clear that the birds of the "non-broody" lines becoming broody in 1917–18 had the character much less intensely developed than the broodies of the flocks of 1912–13 and 1913–14 from which they originated. The mean number of times each broody bird became broody is 1.90 against 5.39. Though the average length of each broody period is longer (Table VIII), the total time spent in broodiness by each broody bird is about one-half that of the broodies of the flock of 1913–14. If the entire flocks of each year (*i.e.*, if the non-broody birds are included in calculating the means) are compared with each other the following significant results are obtained (Table IX): —

TABLE IX. — *A Comparison of the Amount of Broodiness in the Foundation Flock, 1912–13, and their Immediate Unselected Descendants, 1913–14, with their Descendants selected for the Absence of Broodiness, 1917–18.*

DATE.	Number of Birds.	Mean Number of Days spent in Broodiness.	Mean Number of Times Broody.
1912–13, ...	125	65.81	3.88
1913–14, ...	78	68.73	4.91
1917–18, ...	106	10.63	.36

A comparison between the two flocks in respect to egg production (Table VIII) shows that while the 1917–18 flock laid somewhat less rapidly than the 1913–14 flock, the first broody period came later in life (Table X). The mean date of the first broody period is April 18 for the 1913–14 flock, and June 7 for the 1917–18 flock. The 1917–18 flock has a slower rate of production, as shown by the lower percentage production in the initial laying period as well as the later laying periods. On the other hand, the length, both of laying periods and broody periods, is longer

TABLE X. — *Seasonal Distribution of Broodiness in the Flock of 1913–14, and in the Broodies occurring in the Non-broody Lines, 1917–18.*

	Month.	Month in which Individual Broody Periods begin.				Month in which First Broody Period of Each Individual begins.				Month in which Last Broody Period of Each Individual begins.				Month in which Median Broody Period of Each Individual begins.			
		1913-14.		1917-18.		1913-14.		1917-18.		1913-14.		1917-18.		1913-14.		1917-18.	
		Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.	Number.	Per Cent.
1	November,	-	-	-	-	-[1]	-[1]	-	-	-	-	-	-	-	-	-	-
2	December,	5	1.30	-	-	5	7.04	-	-	-	-	-	-	-	-	-	-
3	January,	4	1.04	-	-	3	4.23	-	-	-	-	-	-	-	-	-	-
4	February,	8	2.08	-	-	3	4.23	-	-	-	-	-	-	-	-	-	-
5	March,	19	4.94	-	-	10	14.08	-	-	-	-	-	-	-	-	-	-
6	April,	41	10.68	4	10.53	21	29.58	4	20.00	-	-	-	-	.5	.70	.5	2.50
7	May,	67	17.45	11	28.95	16	22.54	8	40.00	3	4.23	5	25.00	10.5	14.79	6.0	30.00
8	June,	64	16.67	6	15.79	9	12.68	2	10.00	4	5.63	3	15.00	34.0	47.89	5.0	25.00
9	July,	53	13.80	8	21.05	2	2.82	3	15.00	2	2.82	5	25.00	18.0	25.35	5.5	27.50
10	August,	48	12.50	4	10.53	-	-	3	15.00	6	8.45	2	10.00	5.0	7.04	2.0	10.00
11	September,	43	11.20	4	10.53	1	1.41	-	-	26	36.62	4	20.00	2.0	2.82	.5	2.50
12	October,	25	6.51	1	2.63	-	-	-	-	23	32.39	1	5.00	-	-	.5	2.50
13	November,	7	1.82	-	-	1	1.41	-	-	7	9.86	-	-	1.0	1.41	-	-
	Totals,	384	99.99	38	100.01	71	100.02	20	100.00	71	100.00	20	100.00	71.0	100.00	20.0	100.00

[1] Very few birds laying.

in this flock than in that of 1913–14. Just what this means is uncertain. The longer laying periods may be taken as resultant of the reduced tendency toward broodiness, but this is not true for the longer broody periods. The latter may be connected with the slower rate of production.

The experiments in eliminating broodiness are being continued, but a change in the plan of the experiment, to permit of the fusion of the non-broody line with another line known as the high-producing line, has been made. The fusion appears at date of this writing to be accomplished.

Broodiness, in its various sub-characters and in the associated periods of egg production, is decidedly variable as judged by the several coefficients of variation given in Table VIII. Some of the sub-characters are much more variable than others. While some of the characters associated with broodiness are of the same order of variability in the two flocks studied, others are quite unlike, sometimes one and sometimes the other flock being the more variable. The details are best obtained from Table VIII.

Relation between Birds of a Low Degree of Broodiness and Absence of Broodiness.

Some evidence exists that birds that become broody once during the pullet year are not genetically different from those that do not become broody, since the number of broody offspring from each sort of female is approximately the same, as is shown in Table XI. On the other hand, the daughters of birds broody once are somewhat more broody than the daughters of birds not broody at all, as shown in Table XII, which gives a comparison between 14 broody daughters of non-broody mothers and 6 broody daughters of mothers that became broody once, the sires being the same for both lots. It is shown by the per cent production, for both the initial laying period and the subsequent laying periods, that the two sets of birds are about equal in their ability to produce eggs. The daughters whose mothers became broody once were, however, somewhat more broody than the daughters of hens that did not become broody at all, as shown by the length of the initial laying period, the number of broody periods per individual, and the length of the broody periods. Though

Table XI. — *A Comparison between the Number of Broody Offspring from Non-broody Mothers with the Number from Mothers Broody once, the Sires being the Same for Both Lots of Offspring.*

	Number of Mothers.	Broody Offspring.		Non-broody Offspring.	
		Number.	Per Cent.	Number.	Per Cent.
Not broody, ...	15	14	19.45	58	80.55
Broody, ...	3	6	17.65	28	82.35

in this experiment the daughters of non-broody hens are less broody than the daughters of hens broody once, it would be unwise to generalize such a conclusion, because of the very small number of individuals involved.

TABLE XII. — *A Comparison of the Amount of Broodiness in the Daughters of Non-broody Hens with those whose Mothers became Broody once.*

	MOTHERS NOT BROODY IN PULLET YEAR.		MOTHERS BROODY ONCE IN PULLET YEAR.	
	Number of Instances or Individuals.	Mean.	Number of Instances or Individuals.	Mean.
Days of broodiness per individual,	14	31.64	6	49.50
Days in each broody period,	22	18.26	12	24.25
Broody periods per individual,	14	1.79	6	2.17
Days in initial laying period,	14	181.36	6	145.67
Eggs laid in initial laying period,	14	106.93	6	85.83
Per cent production in initial laying period per individual.	14	60.86	6	60.27
Days in each laying period,	22	38.23	12	34.50
Eggs laid in each laying period,	22	21.95	12	19.83
Per cent production in each laying period,	22	65.20	12	64.70
Eggs in each laying period per individual,	14	25.44	6	21.37

Since some birds become broody in their second or third laying years that did not become broody in the first year, the question may be raised as to whether or not a hen may ever be so constituted that it is impossible for her to become broody. We have kept a few hens for four years without evidence of broodiness, but this may not mean that these birds might not have become broody if the proper stimulus had existed. There is the further question as to whether the designation "non-broody" has been accurately used for birds not broody in their pullet year. It might be better to regard such cases as instances of delayed broodiness rather than of the actual absence of broodiness. The delay in the appearance of broodiness in some individuals certainly complicates matters greatly.

THE INTERRELATION OF SEVERAL BROODY CHARACTERS.

The interrelations of several of the broody characters have been studied in the 1913–14 flock by means of the coefficient of correlation. It should, perhaps, be pointed out that the coefficient of correlation does not measure the relationship between the characters as such, but relationship between the numerical occurrence of such characters in the flock studied. This limitation in the use of the coefficient of correlation is often forgotten. Thus it is found that r between number of eggs laid in a year and total days spent in broodiness is $+.1677 \pm .0742$. This value, as shown by its large probable error, is not significant statistically, but, ignoring the error, may perhaps indicate that broodiness is an advantage, since, on the average, those birds spending the most time in broodiness are the heaviest layers. On the contrary, it is known from a study of other data that the very best layers cannot spend much time in broodiness. The interpretation we give this value is that those birds whose laying year begins earliest and stops latest get in more broody periods, other things being equal, than birds whose laying year is shorter.

If an index of production of high value is desired, it is found in the initial laying period, for here the correlation between the length of the period and number of eggs produced is very high, viz., +.8843 ± .0210, a value, moreover, that indicates good homogeneity in rate of production in this flock.

In this flock there is a pronounced negative correlation between egg production during the laying periods and number of broody periods, the coefficient of correlation being —.3453 ± .0716, indicating that those birds that are very broody tend to lay less eggs between broody periods than those having a less number of broody periods. On the other hand, there is no relation between the average (*i.e.*, for one individual) length of laying periods or the eggs produced in such periods and average length of broody periods, since in the first case r = —.0130 ± .0818, and in the second case r = —.0013 ± .0818.

While the above statements hold true for average values, if the coefficient of correlation is determined between the length of a laying period or its egg production and the length of the broody period immediately subsequent thereto, a marked negative correlation is found, being —.2899 ± .0415 in the first instance, and —.3715 ± .0345 in the second. The disagreement between the values obtained when each laying period is correlated with its subsequent broody period, and that found when the average value for each bird is used, is due to a shortening of the laying period and a lengthening of the broody period as the season progresses. This is clearly shown on the individual records.

If, instead of taking a laying period and its subsequent broody period, a broody period is paired with the laying period following, little or no relationship is indicated, for r between length of broody period and subsequent laying period is —.0222 ± .0388, while between length of broody period and subsequent egg production it is only slightly greater, being —.0799 ± .0372.

The interrelationships discussed in the two paragraphs preceding may perhaps be interpreted to mean that heavy laying tends to suppress broodiness, or, at least, that in the flock studied, those birds that laid most heavily had shorter broody periods than those laying less heavily, the tendency to heavy production in such birds enabling them to get back more quickly into production than those in which the tendency was less strong. Longer broody periods, however, and their accompanying element of rest did not conduce to heavier production, a view contrary to that held by most poultrymen.

SUMMARY AND CONCLUSIONS.

The working hypothesis is adopted that —

1. Broodiness depends upon the presence of a "complete mechanism" in the individual, from which it follows that the absence of broodiness depends upon the loss of some essential part of this mechanism, or upon its inhibition by some secondary factor.

2. The inheritance of broodiness may be expected to vary from flock to flock.

3. In the flocks studied, non-broodiness appears to result from the loss of one or both of two genes from the complete germinal complex, while there is some evidence that a dominant inhibitor may also exist in the germ plasm of these flocks.

4. By suitable breeding methods it has been possible to develop quickly a strain of low degree of broodiness from a strain with a very high degree of broodiness.

5. Statistical constants for certain broody characters are given.

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DEPARTMENT OF CHEMISTRY.

THE NUTRITIVE VALUE OF CATTLE FEEDS.

2. OAT BY-PRODUCTS FOR FARM STOCK.

BY J. B. LINDSEY AND C. L. BEALS.

A. The Process of Manufacture.

Oat feed is the residue from the oat meal mills engaged in the preparation of oat products for human consumption.

In the milling process the first step consists in separating the light and double oats and other cereal seeds, as well as sticks and straw, from the oats suitable for human consumption. These latter oats are divided into two or more grades, depending upon size, in order to gain efficiency in milling, and are then roasted or dried in open pans over fire with constant stirring, in order to drive off as much moisture as possible. From the roasters the oats are run over coolers and dusters, and then to the stones which remove the hulls. This latter process, called the first milling or hulling, does not remove all of the hulls, and the unhulled oats are subjected to a second milling to complete the process.

Mill run oat feed contains the hulls, usually reground, together with the middlings and dust removed in the first milling. The residue from the second milling contains a much larger proportion of middlings, and, together with some middlings recovered in cleaning the rolled oats, is used in calf meals and poultry feeds, and is not returned to the oat feed.[1] It is understood that *mill run oat feed*, as above described, should be a comparatively uniform product, especially as produced at the larger plants in the United States. On the other hand, small Canadian mills, because of a less efficient process of separation, are likely to put out an oat feed of better quality than the average run from the larger American mills.

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[1] One large manufacturer states that in its process the middlings and dust from the second milling are also incorporated in the oat feed, and that the material used in calf and pig meals represents the fine oat particles and chips made in cutting groats or shelled oats, together with the fine flakes that come from the rolled oat aspirators, and also the pieces of groats which are unsatisfactory for rolling on account of being broken. It seems reasonable to assume that the process of manufacture may vary somewhat in different establishments.

B. Analyses of Oat By-Products.

In view of the constant increase in the cost of hay and all kinds of concentrates, it was believed that a study of the value of oat by-products was worth while. A visit was therefore made by Mr. P. H. Smith to one of the mills of the Quaker Oats Company and of the H-O Company, the process of manufacture observed, and samples secured for analysis, which were declared by the manufacturers and believed by us to be representative. In addition, several lots of oat feed were shipped us at our request for the purpose of conducting digestion and feeding experiments. The analyses of all of these samples follow: —

Table I. — *Composition of Oat By-Products.*

(*a*) *Oat Hulls.*

Sample No.	Source.	Water.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.	Total.
1	H-O Company (unground), . .	3.82	6.65	.96	33.18	54.99	.40	100
2	Quaker Oats Company (ground), .	5.04	6.15	2.01	31.08	54.78	.94	100
	Average,.	4.43	6.40	1.49	32.13	54.88	.67	100

(*b*) *Oat Middlings and Dust.*

1	H-O Company (first break), . .	4.13	8.00	9.54	23.68	50.57	4.08	100
2	H-O Company (second break), .	5.20	3.40	16.73	5.58	61.14	7.95	100
3	Quaker Oats Company, . . .	5.54	5.94	12.30	15.60	54.97	5.65	100
4	Henry & Morrison,[1] . . .	7.30	3.20	16.30	4.60	61.80	6.80	100

(*c*) *Oat Feed.*

1	H-O Company, mill run, . .	4.24	6.34	6.04	26.65	54.05	2.68	100
2	Quaker Oats Company, mill run, .	5.48	5.95	5.26	27.18	53.98	2.15	100
3	Quaker Oats Company, mill run, .	5.30	6.10	4.65	26.73	55.14	2.08	100
4	Quaker Oats Company, mill run, .	9.53	5.39	5.29	24.17	53.37	2.25	100
5	Quaker Oats Company, mill run, .	7.75	5.91	5.22	24.85	54.04	2.23	100
6[2]	Quaker Oats Company, mill run, .	7.59	6.10	7.12	22.62	53.40	3.17	100
7	Quaker Oats Company, mill run, .	7.03	6.58	6.40	29.82	48.09	2.08	100
8	Quaker Oats Company, mill run, .	7.25	5.86	5.91	26.05	52.80	2.13	100
9	Quaker Oats Company, mill run, .	7.07	5.99	6.00	26.00	52.90	2.04	100
10	Quaker Oats Company, mill run, .	5.48	6.39	5.98	31.85	48.09	2.21	100
11	Quaker Oats Company, mill run, .	7.63	6.24	5.53	27.57	51.04	1.99	100
12	Quaker Oats Company, mill run, .	7.90	5.84	5.04	26.14	53.10	1.93	100
	Average, ...	6.85	6.06	5.70	26.64	52.50	2.24	100

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[1] Average of 23 analyses.

[2] Sample No. 6 evidently contains an excess of middlings, and cannot be considered representative.

The results of the analyses of the two samples of oat hulls simply emphasize their very low protein and fat, — 1.49 of protein and .67 of fat, — and their very high fiber content. The fiber percentage multiplied by 3 gives 96.4 per cent of hulls, indicating the presence of very little dust or middlings.

Oat middlings vary somewhat in composition, depending naturally upon the process of separation employed. The higher the fiber content the less completely are the hulls separated. A high grade of middlings such as results from the second break evidently ought to contain not more than 5 to 6 per cent of fiber, and at least 15 per cent of protein.

The oat feed does not vary more in composition than one would expect from a by-product of this sort. Its moisture content is low, due to artificial drying, showing an average of 6.85 per cent. It has relatively little protein, extremes of from 4.65 to 7.12 being noted, with an average of 5.70 per cent. The fiber content is high, due to the large amount of oat hulls; the average percentage of fiber was 26.64. A much higher percentage of fiber than this average would indicate an excess of hulls. Carefully conducted studies[1] have shown that in case of oat by-products the percentage of fiber present multiplied by 3 will give the percentage of oat hulls. The application of this rule to the average analyses of the twelve samples (26.64 x 3 = 80) shows 80 per cent of hulls and 20 per cent of fine material (oat dust and middlings). The fat percentage in the feed is low, as would be expected.

C. DIGESTIBILITY OF OAT BY-PRODUCTS.

The station has made a number of digestion experiments with oat feed, middlings and hulls. Sheep and horses were employed for the purpose. The results only of the experiments are reported in this connection. Sheep would not eat any amount of the oat feed when fed dry, and hence it was necessary to moisten it thoroughly. It was also moistened before being fed to horses.

TABLE II. — *Digestion Coefficients for Oat By-Products.*

(*a*) *Oat Hulls* (*Sheep*).

SERIES.	Experiment.	Animal.	PERCENTAGES OF INGREDIENTS DIGESTED.						Ration Fed.
			Dry Matter.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.	
24, . . .	13	9	31	16	–	50	29	–	500 g. hay+150 g. gluten feed+150 g. oat hulls.
24, . . .	13	11	36	9	12	51	36	14	
Average, . . .			34	13	12	50	33	14	

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[1] Landw. Versuchssta. Band XCIV, Heft I and II, pp. 9-40, by H. Neubauer.

TABLE II. — *Digestion Coefficients for Oat By-Products* — Concluded.

(*b*) *Oat Hulls* (*Horses*).

SERIES.	Experiment.	Animal.	PERCENTAGES OF INGREDIENTS DIGESTED.						Ration Fed.
			Dry Matter.	Ash.	Protein.	Fiber.	Extract Matter.	Fat.	
3, ...	4	Joe	24	36	123	28	10	76	8,000 g. hay+2,500 g. brewers' grains +2,000 g. oat hulls.
3, ...	4	Tom	20	33	105	15	11	88	
Average, ...			22	34	?	22	11	82	
(*c*) *Oat Middlings* (*Sheep*).									
X, ...	14	IV	91	31	81	77	97	93	550 g. hay+300 g. oat middlings.
X, ...	14	V	88	30	80	21	94	94	
Average, ...			90	36	80	49	95	93	
Wheat flour middlings for comparison.			82	–	88	36	88	86	
(*d*) *Oat Feed* (*Horses*).									
3, ...	5	Joe	40	13	58	51	36	36	8,000 g. hay+2,500 g. oat feed.
3, ...	5	Tom	43	14	54	55	39	69	
Average, ...			42	14	56	53	38	53	
(*e*) *Oat Feed* (*Sheep*).									
24, ...	12	12	51	92	81	39	45	119	500 g. hay+150 g. gluten feed+150 g. oat feed.
24, ...	12[1]	13	19	52	5	1	19	102	
25, ...	11[1]	9	29	–	18	23	31	185	500 g. hay+150 g. oat feed.
25, ...	11[1]	11	27	–	22	21	32	100	
25, ...	13	9	55	26	86	56	49	43	500 g. hay+150 g. gluten+150 g. oat feed.
25, ...	13	11	51	26	90	43	49	46	
25, ...	18	12	57	69	90	57	52	16	500 g. hay+150 g. oat feed.
25, ...	18	13	47	23	86	53	40	67	
Average, ...			52	–	86	46	48	69	
Timothy hay (for comparison).			55	39	47	51	62	50	
Fine hay (extra) (for comparison).			61	44	55	63	62	48	

[1] Excluded from the average.

The results with oat hulls show that the sheep were able to digest 34 per cent of the hulls, and the horses 22 per cent. The protein and fat content of the hulls is quite small, and the coefficients for these ingredients with both sheep and horses are of no particular account. The sheep digested one-half of the fiber and one-third of the extract matter, while the coefficients obtained with the horses were noticeably less. It is possible that in case of the horses, if the hulls had been fed with a different combination than hay and brewers' grains, the results would have been somewhat more favorable. It has been established, however, that horses are not able to utilize fibrous material as well as are the bovines.

The trial with oat middlings was made at this station a number of years since, and has been published.[1] The sample was found in the Massachusetts markets, and was of excellent quality, containing 16.1 per cent of protein, 2.3 per cent of fiber, and 7 per cent of fat. The results are given here to show how well the animal is able to digest oat middlings when substantially free from fiber.

TABLE III. — *Digestible Matter in 2,000 Pounds.*

(*a*) *Sheep.*

FEED.	Dry Matter.	Protein.	Fiber.	Extract Matter.	Fat.	Total Digestible Matter (Fat × 2.2).	Relative Values: Basis Digestible Matter (Oat Feed 100).
Oat hulls, . . .	649.8	3.6	321.4	362.4	1.8	691.3	75
Oat middlings, . . .	1,668.6	260.8	45.0	1,174.2	126.4	1,758.0	191
Oat feed, ...	969.6	99.0	245.4	503.6	31.4	917.7	100
Timothy hay (for comparison).	946.0	76.0	284.0	542.0	20.0	946.0	103
Fine hay (extra) (for comparison).	1,073.6	86.0	358.0	546.0	22.0	1,038.0	113

(*b*) *Horses.*

FEED.	Dry Matter.	Protein.	Fiber.	Extract Matter.	Fat.	Total Digestible Matter (Fat × 2.2).	Relative Values: Basis Digestible Matter (Oat Feed 100).
Oat feed, ...	782.0	64.4	282.0	338.0	24.0	737.2	100
Timothy hay, . . .	756.8	33.6	243.4	410.8	39.4	727.2	98.6

On the basis of the digestion experiments with sheep, it will be seen that oat feed contains 918 pounds of total digestible matter as against 1,758 for oat middlings, 691 for oat hulls, and 946 for timothy hay. Placing oat feed at 100, oat middlings would have a feeding value of 91 per cent more, oat hulls 25 per cent less, and timothy 3 per cent more.

On the basis of digestible organic matter, the oat feed and timothy appear to have about equivalent feeding values for horses. In place of digestible matter as a measurement of nutritive value, Kellner and also Armsby, as a result of more recent investigations, have adopted the unit of net energy. While recognizing its superiority over digestible matter as a basis for comparison, the writers feel that sufficient data are not available to warrant its use in the case of oat by-products.

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[1] Mass. Agr. Expt. Sta., Ann. Rept. 19, p. 114.

D. Oat Feed for Dairy Cows.

Experiments I, II, and III.

In addition to the numerous analyses and digestibility trials with the several oat by-products, it was thought necessary to observe the effect of oat feed upon milk production. Inasmuch as it approximated hay in digestibility, it was fed in comparison with hay. Thus fed, a larger amount could be given daily than if used as a component of a grain mixture.

The experiments, three in number, with eight, four and eleven cows, respectively, were conducted by the usual reversal method. The basal ration consisted of a uniform grain mixture and sufficient of a first quality of cow hay to meet the needs of each animal. In each half of the experiment a definite amount of oat feed *on a dry matter basis* was substituted for a like weight of hay, amounting in case of individual cows to from 6 to 8 pounds daily. It was fed well moistened with water and was readily eaten. The average daily ration fed will be found in Table VIII.

TABLE IV. — *History of the Cows.*

EXPERIMENT I.

NAME.	Age.	Breed.	Calved.	Served.	Milk Yield, Beginning (Pounds).	Fat (Per Cent).
Peggy,	9	G. Jersey,	Aug. 13, 1918	Dec. 26, 1918	18	6.4
190,	7	G. Holstein,	Dec. 3, 1918	Feb. 9, 1919	25	3.8
Colantha II,	4	G. Holstein,	July 22, 1918	Nov. 7, 1918	25	4.5
Red IV,	6	G. Jersey,	Mar. 7, 1919	– –	30	5.0
Fancy IV,	4	G. Jersey,	July 22, 1918	Oct. 30, 1918	16	5.5
Ida II,	6	P. Jersey,	Oct. 27, 1918	Feb. 13, 1919	23	6.0
Samantha III,	6	G. Holstein,	Aug. 26, 1918	Dec. 5, 1918	20	4.7
Betty II,	12	G. Ayrshire,	Jan. 24, 1919	Feb. 19, 1919	30	4.6

EXPERIMENT II.

190,	8	G. Holstein,	Nov. 17, 1919	– –	31	4.4
Cecile II,	7	P. Jersey,	Oct. 12, 1919	– –	21	5.6
Ida II,	7	P. Jersey,	Nov. 22, 1919	– –	30	6.0
Peggy,	10	G. Jersey,	Oct. 9, 1919	– –	23	6.2

EXPERIMENT III.

Cecile II,	7	P. Jersey,	Oct. 12, 1919	Feb. 24, 1920	18	6.2
Diantha II,	3	G. Holstein,	Jan. 22, 1920	– –	34	3.4
Colantha II,	5	G. Holstein,	Aug. 8, 1919	Nov. 3, 1919	33	4.2
Ida II,	7	P. Jersey,	Nov. 22, 1919	Feb. 10, 1919	26	6.2
Samantha III,	6	G. Holstein,	Sept. 12, 1919	Dec. 8, 1919	29	4.0
Colantha,	6	G. Holstein,	Sept. 19, 1919	Feb. 4, 1920	21	4.3
Fancy IV,	5	G. Jersey,	Aug. 10, 1919	Nov. 15, 1919	18	5.5
Eantha,	3	G. Holstein,	Jan. 19, 1919	– –	28	3.6
Samantha IV,	5	G. Holstein,	Aug. 20, 1919	Dec. 4, 1919	32	4.6
Peggy,	10	G. Jersey,	Oct. 9, 1919	Feb. 4, 1919	24	6.4
190,	8	G. Holstein,	Nov. 17, 1919	Jan. 2, 1920	31	4.4
Red IV,	6	G. Holstein,	Jan. 14, 1919	– –	32	4.9

TABLE V. — *Duration of Experiments.*

EXPERIMENT I.

DATES.	Hay Ration.	Hay and Oat Feed Ration.	Weeks Fed.
April 3, 1919, through April 30, 1919,	Fancy IV,	Peggy,	4
	Ida II,	190,	
	Samantha III,	Colantha II,	
	Betty II,	Red IV,	
May 11, 1919, through June 7, 1919,	Peggy,	Fancy IV,	4
	190,	Ida II,	
	Colantha II,	Samantha III,	
	Red IV,	Betty II,	

EXPERIMENT II.

Dec. 24, 1919, through Jan. 27, 1920,	Ida II,	190,	5
	Peggy,	Cecile II,	
Feb. 8, 1920, through March 13, 1920,	190,	Ida II,	5
	Cecile II,	Peggy,	

EXPERIMENT III.

April 1, 1920, through May 5, 1920,	Fancy IV,	Cecile II,	5
	Eantha,	Diantha II,	
	Samantha IV,	Ida II,	
	Peggy,	Samantha III,	
	190,	Colantha,	
	Red IV,		
May 16, 1920, through June 19, 1920,	Cecile II,	Fancy IV,	5
	Diantha II,	Eantha,	
	Ida II,	Samantha IV,	
	Samantha III,	Peggy,	
	Colantha,	190,	
		Red IV,	

Care of the Animals. — The animals were cared for in the usual way, as described in previous experiments.

Sampling Feeds and Milk. — The hay was sampled three times during each half of the trial, by taking forkfuls here and there, running the same through a power cutter, sub-sampling, and placing the sub-samples in glass-stoppered bottles which were brought to the laboratory at once, dry matter determinations made, and composite samples analyzed. The grain mixtures were sampled each time a new lot was mixed, and the samples placed in glass-stoppered bottles for analysis. The oat feed was sampled at regular intervals during the experiment.

The milk was sampled for five consecutive days for two or three weeks during each half of the trial, preserved with formalin, and analyzed for total solids and for fat by the Babcock method. The usual method of sampling was followed as described in previous experiments.

TABLE VI. — *Grain Mixtures fed* (*Pounds*).

Experiment I.		Experiment II.		Experiment III.	
Coconut meal,	50	Coconut meal,	40	Coconut meal,	30
Velvet bean feed,	20	Gluten feed,	30	Gluten feed,	10
Wheat bran,	20	Wheat bran,	30	Wheat bran,	20
Linseed meal,	10			Corn meal,	30
				Peanut meal,	10

Notes of the Experiment. — In Experiment I, a preliminary test of the oat feed used showed it to contain 4.95 per cent of protein and 26.89 per cent of fiber, and it was regarded as a representative lot. The final analysis, however, made from a number of different samples, gave 7.12 per cent of protein and 22.62 per cent of fiber, indicating the presence of an undue amount of oat middlings. The results of this experiment are reported, but they are not included in the average.

In Experiment III, twelve cows were employed, but during the progress of the experiment Colantha II showed such an abnormal milk shrinkage that she could not be continued, and the experiment was completed with eleven cows.

TABLE VII. — *Chemical Analysis of Feeds used (Per Cent).*

EXPERIMENT.	Feed.	Water.	Ash.	Crude Protein.	Fiber.	Extract Matter.	Fat.
I, . . .	Hay, . . .	10.00–11.63 10.85	5.34	7.27	26.09	47.81	2.64
	Oat feed, . . .	7.59	6.10	7.12	22.62	53.40	3.17
	Grain mixture, .	10.24	5.62	18.71	8.90	50.19	6.34
II, . . .	Hay, . . .	9.50–10.25 9.72	5.62	8.42	29.49	44.22	2.53
	Oat feed, . . .	7.63	6.24	5.53	27.57	51.04	1.99
	Grain mixture, .	11.08	5.64	20.90	9.10	48.24	5.04
III, . .	Hay, . . .	10.96–11.96 11.46	4.23	6.98	26.70	48.08	2.55
	Oat feed, . . .	7.90	5.84	5.04	26.14	53.10	1.93
	Grain mixture, .	11.77	4.28	18.18	5.87	53.86	6.07

The hay was of good to excellent quality. It contained a considerable proportion of the finer grasses, together with some timothy and clover, and was usually cut before it was too ripe. Its fiber percentage was not unduly high, and it contained a reasonable amount of protein. Attention has already been called to the fact that the first sample of oat feed contained too large a per cent of middlings to be representative, as is indicated by its relatively low fiber and high protein and fat.

The grain mixtures contained the desired amounts of the several ingredients, and were of satisfactory composition.

A study of Table VIII shows that the average cow received the same amount of grain daily during each experiment. In case of roughage, from 6 to 8 pounds of oat feed were substituted for a like amount of hay *on a dry matter basis*. Because of the dryer condition of the oat feed, it took .5 of a pound less of oat feed in its natural condition to replace a like amount of hay, *e.g.*, 6.5 pounds of oat feed in place of 7 pounds of hay, or 8 pounds of oat feed in place of 8.5 pounds of hay, or 7.64 pounds of oat feed in place of 8.14 pounds of hay. If 8 pounds of hay in its natural state had been fed in place of 8 pounds of oat feed in its natural state the results should have been slightly more favorable to the oat feed.

TABLE VIII. — *Average Ration Consumed per Cow (Pounds).*

EXPERIMENT I.

NUMBER OF COWS.	Character of Ration.	HAY.		OAT FEED.		GRAIN MIXTURE.	
		Total per Cow.	Daily per Cow.	Total per Cow.	Daily per Cow.	Total per Cow.	Daily per Cow.
8, ...	Oat feed, . .	392.00	14.00	182.00	6.50	252.00	9.00
8, ...	Hay, . . .	588.00	21.00	–	–	252.00	9.00
EXPERIMENT II.							
4, ...	Oat feed, . .	402.00	11.50	280.00	8.00	324.00	9.25
4, ...	Hay, . . .	700.00	20.00	–	–	324.00	9.25
EXPERIMENT III.							
11, ...	Oat feed, . .	447.05	12.77	270.45	7.64	308.64	8.82
11, ...	Hay, . . .	731.82	20.91	–	–	308.64	8.82

TABLE IX. — *Estimated Dry and Digestible Nutrients in Average Daily Rations (Pounds).*

EXPERIMENT I.

CHARACTER OF RATION.	Dry Matter.	DIGESTIBLE NUTRIENTS.					Nutritive Ratio.
		Protein.	Fiber.	Extract Matter.	Fat.	Total.	
Oat feed, . . .	26.28	2.34	3.05	9.31	.86	15.57	1:6.06
Hay, ...	26.73	2.24	3.59	9.74	.77	16.34	1:6.71
EXPERIMENT II.							
Oat feed, . . .	25.98	2.55	3.56	8.86	.61	15.58	1:54.00
Hay, ...	26.27	2.56	4.13	9.24	.60	16.53	1:57.00
EXPERIMENT III.							
Oat feed, . . .	26.22	2.11	3.24	9.89	.71	15.95	1:6.96
Hay, ...	26.32	2.09	3.71	10.33	.71	16.84	1:7.52

The above figures are based upon analyses and average digestion coefficients. On this basis, in each of the three experiments, the hay ration appears to have contained a little more total digestible nutrients than the oat feed ration. The two rations in each experiment contained about the same amounts of protein and fat.

TABLE X. — *Total Yields of Milk and Milk Ingredients.*

EXPERIMENT I.

Oat Feed Ration.

Cows.	Milk produced (Pounds).	Total Solids (Per Cent).	Total Solids (Pounds).	Fat (Per Cent).	Fat (Pounds).
Peggy,	556.7	16.18	90.07	7.23	40.25
190,	747.1	12.89	96.30	4.53	33.84
Colantha II,	649.7	14.80	96.16	5.47	35.54
Red IV,	998.7	14.19	141.72	5.55	55.43
Fancy IV,	443.6	15.18	67.34	5.99	40.34
Ida II,	681.9	15.00	102.29	6.25	63.93
Samantha III,	560.0	13.92	77.95	5.08	39.60
Betty II,	848.1	13.37	113.39	4.93	55.90
Totals,	5,485.8	–	785.22	–	364.83
Averages,	–	14.31	–	6.65	–

Hay Ration.

Peggy,	492.9	16.10	79.36	6.78	53.81
190,	710.2	12.75	90.55	4.39	39.75
Colantha II,	447.0	14.78	66.07	5.44	35.94
Red IV,	860.6	13.39	115.23	5.50	63.38
Fancy IV,	455.2	15.43	70.24	5.93	26.99
Ida II,	695.1	15.35	106.70	6.24	43.37
Samantha III,	591.7	14.21	84.08	5.32	31.48
Betty II,	884.0	13.78	121.82	4.93	43.58
Totals,	5,136.7	–	734.05	–	338.30
Averages,	–	14.29	–	6.58	–

Table X. — *Total Yields of Milk and Milk Ingredients* — Continued.

Experiment II.

Oat Feed Ration.

Cows.	Milk produced (Pounds).	Total Solids (Per Cent).	Total Solids (Pounds).	Fat (Per Cent).	Fat (Pounds).
190,	1,115.4	12.53	139.76	4.33	48.30
Cecile II,	695.1	14.79	105.59	5.86	41.83
Ida II,	877.2	14.85	130.26	6.00	52.63
Peggy,	806.0	15.12	121.88	6.43	51.83
Totals,	3,512.6	–	497.49	–	194.59
Averages,	–	14.16	–	5.54	–

Hay Ration.

190,	1,060.9	12.66	134.31	4.25	45.09
Cecile II,	640.6	15.33	98.20	6.24	39.97
Ida II,	973.6	14.93	145.36	6.09	59.29
Peggy,	799.3	15.17	121.25	6.50	51.95
Totals,	3.474.34	–	499.12	–	196.30
Averages,	–	14.37	–	5.65	–

Experiment III.

Oat Feed Ration.

Cecile II,	612.0	15.37	94.06	6.37	38.98
Diantha II,	1,164.5	12.11	141.02	3.88	45.18
Ida II,	858.9	14.92	128.15	6.03	51.79
Samantha III,	873.3	13.26	115.80	4.70	41.05
Colantha,	802.7	12.78	102.59	4.50	36.12
Fancy IV,	586.0	14.83	86.90	5.65	33.11
Eantha,	833.5	12.53	104.44	4.07	33.92
Samantha IV,	963.2	13.25	127.62	4.84	46.62
Peggy,	757.7	15.19	115.09	6.30	47.74
190,	915.4	13.05	119.46	4.44	40.64
Red IV,	1,009.6	14.45	145.89	5.60	56.54
Totals,	9,376.8	–	1,281.02	–	471.69
Averages,	–	13.66	–	5.03	–

TABLE X. — *Total Yields of Milk and Milk Ingredients* — Concluded.

EXPERIMENT III — *Concluded.*

Hay Ration.

Cows.	Milk produced (Pounds).	Total Solids (Per Cent).	Total Solids (Pounds).	Fat (Per Cent).	Fat (Pounds).
Cecile II,	583.6	15.22	88.82	6.07	35.42
Diantha II,	1,081.1	11.67	126.16	3.52	38.05
Ida II,	791.9	14.43	114.27	5.54	43.87
Samantha III,	597.9	13.79	82.45	5.01	29.95
Colantha,	724.5	12.71	92.08	4.74	34.34
Fancy IV,	606.0	14.98	90.78	5.88	35.63
Eantha,	853.1	12.58	107.32	4.23	36.09
Samantha IV,	1,047.3	13.30	139.29	4.76	49.85
Peggy,	744.3	15.29	113.80	6.59	49.05
190,	967.3	13.08	126.52	4.52	43.72
Red IV,	1,029.5	14.04	144.54	5.56	57.24
Totals,	9,026.5	–	1,226.03	–	453.21
Averages,	–	13.58	–	5.02	–

TABLE XI. — *Summary of Yields (Pounds).*

EXPERIMENT.	Character of Ration.	Number of Cows.	Milk produced.	Total Solids.	Total Fat.
I,	Oat feed,	8	5,485.8	785.22	364.83
	Hay,		5,136.7	734.05	338.30
II,	Oat feed,	4	3,512.6	497.49	194.59
	Hay,		3,474.3	499.12	196.30
III,	Oat feed,	11	9,376.8	1,281.02	471.69
	Hay,		9,026.5	1,226.03	453.21
Totals, II and III,	Oat feed,	15	12,889.4	1,778.51	666.28
	Hay,		12,500.8	1,725.15	649.51

TABLE XII. — *Percentage Increase Oat Feed Over Hay.*

Experiment.	Milk produced.	Total Solids.	Total Fat.
I,	6.7	7.0	7.8
II,	1.1	–	0.9
III,	3.9	4.5	4.1
Totals, II and III,	3.1	3.0	2.5

The results of Experiment I have been omitted from the average because of the variation of the lot of oat feed from the recognized standard. The results of Experiments II and III with four and eleven cows, respectively, covering periods of five weeks each, show that the substitution of from 7 to 8 pounds of dry matter in the form of oat feed for a like amount of dry matter in the form of a good quality of hay (8 pounds and 7.64 pounds of oat feed in place of 8.5 pounds and 8.14 pounds of hay in natural condition) produced substantially 3 per cent more milk and milk ingredients.

TABLE XIII. — *Gain or Loss in Live Weight (Pounds).*

Experiment.	Gain.		Loss.		Net.	
	Oat Feed Ration.	Hay Ration.	Oat Feed Ration.	Hay Ration.	Oat Feed Ration.	Hay Ration.
I,	79	38	56	78	23+	40—
II,	12	15	47	53	35—	38—
III,	231	180	37	50	194+	130+
Averages, II and III,	–	–	–	–	159+	92+

During the experiments the cows on the two different rations showed little change in weight. Our object in each experiment was to feed them a little less than was required for maintenance and milk yield, in order to get, so far as possible, the full effect of each ration. In Experiment III some of the cows were considerably advanced in lactation, at which time they are prone to increase somewhat in weight.

E. Oat Feed for Horses.

Oat feed has been fed to a pair of farm horses, Joe and Chub, at intervals for a period of five months, beginning in early May. The horses had been used for digestion work during the winter, and it was necessary during the early spring to bring them on to a full day's work by degrees. They were employed in plowing, harrowing, drawing manure, mowing, and in similar work for nine hours daily during five and one-half days in each week.

The oat feed was substituted for the hay, at first in the proportion of 5 pounds, and later 6 pounds, daily.

The "grain mixture" consisted of 10 pounds of cracked corn, 1 pound of wheat bran, and 1 pound of cottonseed meal. The object of feeding the cottonseed was to furnish some extra protein in the ration, and to note if any objectionable effect occurred from its use. The wheat bran was used not only for its nutritive value, but because of its gentle laxative effect.

Table XIV. — *Daily Rations consumed* (*Pounds*).

Periods.	Joe.				Chub.			
	Grain Mixture.	Whole Oats.	Hay.	Oat Feed.	Grain Mixture.	Whole Oats.	Hay.	Oat Feed.
May 3–June 13, . .	12	5	15	–	11	5	9	5
June 14–July 11, . .	12	5	10	5	11	5	14	–
July 12–August 8, . .	12	5	15	–	11	5	8	6
August 9–September 12,	12	5	9	6	11	6	14	–

The table shows that each horse received daily 12 and 11 pounds, respectively, of the grain mixture of corn, cottonseed and bran. This amount was divided into two feeds, and given in the morning and evening. At noon each horse received 5 pounds of oats. From May 3 to June 13, inclusive, Joe received daily 15 pounds of hay and no oat feed, while Chub received 9 pounds of hay and 5 pounds of oat feed. From June 14 to July 11, inclusive, the conditions for the coarse feed were reversed, Joe receiving the hay and oat feed and Chub the hay only. Conditions were again reversed July 12–August 8, and again August 9–September 12, so that during each period from May 1 through September 12 one of the horses was receiving hay for roughage and the other a limited amount of hay and 5 or 6 pounds daily of the oat feed. The latter was well moistened before being fed, and given in three portions. The horses objected a little to the oat feed at first, but soon learned to eat it readily.

TABLE XV. — *Estimated Digestible Nutrients consumed Daily (Pounds).*

RATION FED.	Protein.	Total (Fat × 2.2).	Nutritive Ratio.
15 pounds hay, 5 pounds oats, 10 pounds cracked corn, 1 pound cottonseed meal, 1 pound wheat bran.	2.40	20.20	1:7.4
9 pounds hay, 6 pounds oat feed, 5 pounds whole oats, 10 pounds cracked corn, 1 pound cottonseed meal, 1 pound wheat bran.	2.30	19.50	1:7.5
Standards for comparison: —			
Kellner's (moderate work),	2.00	17.70	1:8.0
Kellner's (hard work),	2.80	24.50	1:7.7
Lavalard's (moderate work),	1.86	18.10	1:8.3
Grandeau's (moderate work),	2.20	17.96	1:7.9

The horses approximated 1,400 pounds each in weight. The above figures show the estimated digestible nutrients that were fed daily and the standard requirements for horses weighing 1,400 pounds, as stated by different authorities. It seems clear that the horses, which were doing moderately hard work, were receiving sufficient digestible protein and total nutrients. It is doubtful if they would have kept in good condition with less food.

TABLE XVI. — *Weights of Animals.*

Joe.

DATES.	Weeks.	Character of Ration.	Weight, Beginning.	Weight, End.	Gain or Loss.
May 3–June 13,	6	Hay,	1,430	1,410	20—
June 14–July 11,	4	Hay-oat feed,	1,410	1,435	25+
July 12–August 8,	4	Hay,	1,435	1,425	10—
August 9–September 12,	5	Hay-oat feed,	1,425	1,440	15+

Chub.

DATES.	Weeks.	Character of Ration.	Weight, Beginning.	Weight, End.	Gain or Loss.
May 3–June 13,	6	Hay-oat feed,	1,370	1,350	20—
June 14–July 11,	4	Hay,	1,350	1,375	25+
July 12–August 8,	4	Hay-oat feed,	1,375	1,390	15+
August 9–September 12,	5	Hay,	1,390	1,430	40+

General Effect of the Ration.

The animals were weighed weekly, and minor variations were noted. Weights at the beginning and end of the change of ration are here given. The weights indicate that Joe evidently was receiving sufficient food to keep him in equilibrium and to enable him to do his work in a satisfactory way, while Chub was receiving a little more than was necessary. The latter was shorter of leg and chunkier in build, and would be termed an easy keeper. During the first period of six weeks (May 3–June 13) both horses lost a little in weight, due to the work required after a winter of comparative inaction. In the second period of four weeks (June 14–July 11) each horse gained 25 pounds irrespective of the ration, due probably to the less amount of work performed. During the third period of four weeks (July 12–August 8) Joe on the hay ration lost 10 pounds, and Chub on the hay-oat feed ration gained 15 pounds, while in the last period of five weeks both horses gained somewhat, probably because of the less strenuous character of the daily work requirements.

Summary and Discussion.

The term "oat feed" does not refer to ground oat hulls, but to the so-called "mill run" resulting from the first milling of oats. The product from the large modern mills contains some 80 per cent of hulls and 20 per cent of middlings and dust. Because of the finely ground condition of the hulls as placed upon the market it is not possible to separate the hulls from the middlings by mechanical means. An average quality of oat feed contains 5 to 6 per cent of protein, about 2 per cent of fat, and not over 27 per cent of fiber. Less protein and fat and more fiber indicate an excess of hulls, while more protein and fat and less fiber show an extra amount of middlings, and consequently a superior product.

While in digestibility oat feed falls a little below hay, feeding trials with dairy cows have shown it to be slightly superior in the production of milk.

In case of horses, the feeding of 5 to 6 pounds daily of oat feed in place of a like amount of hay was productive of quite satisfactory results, and no disturbances of any kind were noted during the four and a half months of the trial. It may be possible to substitute more than 6 pounds of oat feed for a like amount of hay, but we should hardly advise it, both because of its lack of palatability and its lack of bulk as compared with hay. The feeding of 1 pound of cottonseed meal daily in the grain mixture was in no way injurious, so far as we were able to observe, and it is believed that the extra protein furnished had a favorable effect upon the animals.

The writers are of the opinion that oat feed, if placed upon the market unmixed, can best be used pound for pound as a partial hay substitute for dairy cows, young stock, fattening cattle and horses, providing the supply of hay is limited and oat feed can be bought at a reasonable price.

From 6 to 8 pounds daily can thus be fed (well moistened) to mature bovines, proportionately less to young stock, and about 5 to 6 pounds daily to horses.

While oat feed is used in considerable amounts in many proprietary grain mixtures, the best grades, whether rich in protein or carbohydrates, cannot contain large quantities for the reason that such an addition would unduly increase their fiber content and also lessen their digestibility.

The claim is made that aside from its nutritive value, oat feed possesses merit as bulk, serving to distribute and lighten the heavier concentrates. How valid this claim is has not been proved, although as a result of experience many feeders claim that the feeding of considerable amounts of a grain ration which lacks bulk is not advisable. Be that as it may, the use of a few hundred pounds (about 15 per cent) of oat feed in a ton of home-mixed ration would not be objectionable, especially if the other ingredients are highly digestible and finely ground.

In view of the ever-increasing demand for the grains as human food, it should be the aim of both the manufacturer and feeder to use the by-products to the best advantage. Methods for improving the digestibility of indigestible materials, such as grain hulls and the like, merit the careful attention of investigators.

Oat feed should bear a guarantee of composition, and the manufacturers should be careful that it is of stable composition. The purchaser will lose confidence if it shows variations from an accepted standard, or if material is offered as oat feed which consists only of ground oat hulls.

Low-grade by-products, of which oat feed is a type, must be *sold on their merits* and at a price commensurate with their feeding value. Any attempt to sell such material either by itself or in proprietary mixtures at prices unwarranted by its feeding value as compared with feeding stuffs of higher grade would quickly destroy the confidence of the purchaser and result in a slackened demand for the article. The old motto of "state what you sell and sell what you state" may be improved by the addition of the clause "at a price commensurate with its value," and would be especially applicable to this class of materials.

INDEX

INDEX.

PAGE

Advanced registry work, ... 29*a*

Alfalfa sown with peas and oats for forage, ... 24*a*

Animal nutrition:

  Digestion studies with sheep, ... 23*a*

  Experiments with pigs, ... 24*a*

  Metabolizable energy trials with horses, ... 24*a*

  Oat by-products, ... 23*a*, 117

Aphicide, value as an insecticide, ... 37*a*

Apiary, care of, ... 42*a*

Apples, interrelation of stock and scion, ... 46*a*

  Pruning experiments, ... 46*a*

Arsenic, white, as an insecticide in Bordeaux mixture, ... 39*a*

Asparagus, Martha Washington, ... 48*a*

Bacillary white diarrhea, control work, ... 56*a*

  Diagnosis, ... 57*a*

Bacterized peat, ... 27*a*, 28*a*

Barium-Phosphate test, ... 48*a*

Blueberry studies, ... 34*a*

Broodiness in domestic fowl, ... 93

Bulletin No. 195, Tobacco investigations: progress report, . . . 1

Bulletin No. 196, Methods of applying manure, ... 39

Bulletin No. 197, The nutritive value of cattle feeds. 1. Velvet bean meal for farm stock, ... 61

Bulletin No. 198, Studies of cranberries during storage: chemical studies, 75

  Fungi studies, ... 88

Bulletin No. 199, Broodiness in domestic fowl: data concerning its inheritance in the Rhode Island Red breed, ... 93

Bulletin No. 200, The nutritive value of cattle feeds. 2. Oat by-products for farm stock, ... 117

Butter fat studies, ... 23*a*

Buttermilk, semi-solid and evaporated, for pigs, ... 24*a*

Canning, ... 44*a*

Chemical changes in cranberries in storage, ... 75

Chemical work, numerical summary, ... 31*a*

Clover, effect of nitrogen on, ... 15*a*

Clover, response to potash, ... 16*a*

Clovers with peas and oats for forage, ... 24*a*

Codling moth, importance of, ... 36*a*

College barn, elimination of disease, ... 58*a*

College poultry plant, elimination of disease, ... 59*a*

Comparison of nitrogen field (A), potash field (G) and phosphate field, . 17*a*

Consumers' Co-operation in Massachusetts, ... 12*a*

Control work:

  Dairy law, ... 28*a*

  Feeding stuffs law, ... 28*a*

  Fertilizer law, ... 26*a*

  Poultry disease law, ... 56*a*

Co-operative consumers' organizations in Massachusetts, ... 12*a*

PAGE
Corn, effect of nitrogen, phosphoric acid and potash on, ... 17*a*
Corn, response to potash, ... 16*a*
Cover crops for tobacco, ... 21
Cows:
  Oat feed for, ... 122
  Testing for advanced registry, ... 29*a*
  Velvet bean feed for, ... 64
Cranberries during storage:
  Chemical studies, ... 75
    Chemical changes in cranberries in storage, ... 75
    Cranberry vinegar, ... 85
    Keeping qualities of cranberries in cold storage, ... 83
    Methods, ... 86
    Respiration of cranberries, ... 80
    Summary, ... 85
  Fungi studies, ... 88
    Relative prevalence of fungi causing rots of cranberries at different periods during the storage season, ... 88
Cranberries, disease control, ... 34*a*
  Fertilizer tests, ... 34*a*
  Insects, ... 32*a*
  Respiration of, ... 25*a*, 80
  Storage tests, ... 34*a*
  Utilization of poor-grade berries, ... 45*a*
  Varieties, ... 34*a*
  Yield in 1920, ... 35*a*
Cucumbers, greenhouse, variety test, ... 48*a*
Dairy law, ... 28*a*
Departmental organization, changes in, ... 4*a*
Digestion studies with sheep, ... 23*a*
Digger wasps, studies, ... 37*a*
Farm ownership in Massachusetts, ... 13*a*
Feeding stuffs law, report of inspection, ... 28*a*
Fertilizer experiments:
  Barium-Phosphate test, ... 48*a*
  Manure economy test, ... 48*a*
  Nitrogen tests (Field A), ... 15*a*, 17*a*
  Peat with and without bacteria, ... 27*a*, 28*a*
  Phosphate tests (phosphate field), ... 17*a*
  Potash tests (Field G), ... 16*a*, 17*a*
  South soil test, ... 15*a*
  With cranberries, ... 34*a*
  With tobacco, ... 31
Fertilizer inspection, ... 26*a*
Food studies, microbiological, ... 52*a*
Forage crops, ... 24*a*
  Alfalfa or clovers with peas and oats, ... 24*a*
  Soy beans planted with corn, ... 24*a*
  Sudan grass, ... 24*a*
Frost prediction at Cranberry Station, ... 33*a*
Fruit juices, ... 44*a*
Fruit varieties, tree characters of, ... 46*a*
Fruits, economic values of varieties for manufacturing purposes, . . . 44*a*
Fungi causing rots of cranberries, ... 88
Fungicides and insecticides, chemical studies, ... 23*a*
Grass, effect of nitrogen, phosphoric acid and potash on, ... 17*a*

PAGE

Greenhouse tests of cucumbers, ... 48*a*
  Of lettuce, ... 49*a*
Gypsy moths found in Amherst, ... 43*a*
Hay, response to potash, ... 16*a*
Hog cholera studies, ... 57*a*
Horses, metabolizable energy trials with, ... 24*a*
Horses, oat feed for, ... 132
Horses, velvet bean feed for, ... 74
Inheritance of broodiness in the Rhode Island Red breed, . . . 93
Insect studies:
  Codling moth, ... 36*a*
  Digger wasps, ... 37*a*
  Onion maggot, ... 36*a*
  Scales, ... 36*a*
  Squash bug, ... 37*a*
  Squash-vine borer, ... 37*a*
Insecticides, tests of:
  Aphicide, ... 37*a*
  Dry sulfides, ... 41*a*
  Standard insecticides, ... 37*a*
  Sulco V. B., ... 38*a*
  White arsenic, ... 39*a*
Insecticides and fungicides, chemical studies, ... 23*a*
Insects, cranberry, ... 32*a*
Jelly making, ... 44*a*
Land, lack of, ... 7*a*, 34*a*
Lettuce, greenhouse, test of, ... 49*a*
Light, optimum conditions for plant response, ... 20*a*
Manure economy test, ... 48*a*
Manure, methods of applying, ... 39
  Bibliography, ... 60
  Conclusions apparently justified at the end of the period of annual application, ... 49
  Effect of the two systems previously followed in the application of manure on growth during the early part of the season and the maturing of the crop, ... 53
  Final conclusions, ... 58
  Financial results, ... 56
  Introduction, ... 39
  Plan of the experiment, ... 40
  Relative effects of the two systems of manuring on crop yields, . . 44
  Relative effects of the two systems on the proportion of clover in mixed mowings, ... 54
  Relative lasting effects of winter and spring application, . . . 50
  Varying effect of the systems of manuring on the cover crop of rye, . 49
  Why clover has been more abundant on plots S, ... 55
Meteorology, work of the department, ... 50*a*
Microbiology, work of the department, ... 52*a*
  Dairy studies, ... 52*a*
  Food studies, ... 52*a*
  Miscellaneous work, ... 53*a*
  Soil studies, ... 53*a*
Needs of the Station:
  Assistants, ... 8*a*, 14*a*, 22*a*
  Land, ... 7*a*, 34*a*
  Substation in hill region west of the Connecticut River, . . . 8*a*

PAGE

Nitrogen, effect on clover, ... 15*a*
Nitrogen field (Field A), ... 15*a*
  Chemical studies of soil of, ... 25*a*
Nutritive value of cattle feed:
  Oat by-products for farm stock, ... 117
  Velvet bean feed for farm stock, ... 61
Oat by-products for farm stock:
  Analyses of oat by-products, ... 118
  Digestibility of oat by-products, ... 119
  Oat feed for dairy cows, ... 122
  Oat feed for horses, ... 132
  Process of manufacture, ... 117
  Summary and discussion, ... 134
Onion disease investigation, ... 19*a*
Onion maggot, ... 36*a*
Onion supply and distribution in the Connecticut valley, ... 13*a*
Pasture for pigs, ... 24*a*
Peaches, genetic composition, ... 46*a*
Peat, bacterized, vegetation tests with, ... 27*a*, 28*a*
Pigs:
  Pasture for, ... 24*a*
  Semi-solid and evaporated buttermilk for, ... 24*a*
  Velvet bean feed for, ... 71
Plant diseases:
  Apple, ... 21*a*
  Carrot, ... 20*a*
  Cranberry, ... 34*a*
  Eggplant, ... 21*a*
  Onion, ... 19*a*
  Potato, ... 21*a*
  Tobacco, ... 20*a*, 23
  Tomato, ... 20*a*
Plants, optimum conditions of light for, ... 20*a*
Potash, response of crops to, ... 15*a*
Potatoes, response to potash, ... 16*a*
Poultry:
  Broodiness in:
    Germinal basis of broodiness, ... 102
    Interrelation of several broody characters, ... 114
    Introduction, ... 93
    Literature cited, ... 116
    Modifying factors for broodiness, ... 106
    Production of a strain of low degree of broodiness through selection, . 107
    Recognition and treatment of broody birds, ... 95
    Relation between birds of a low degree of broodiness and absence of broodiness, ... 113
    Summary and conclusions, ... 116
    The material and its treatment, ... 95
    Variation in amount of broodiness, ... 96
  Elimination of disease, ... 54*a*
  Work of the department, ... 54*a*
Project system, ... 5*a*
Projects now under way, ... 6*a*
Pruning experiments with apple trees, ... 46*a*
Publications of the year, ... 4*a*
Report of the director, ... 3*a*

PAGE

Report of the treasurer, ... 10*a*
Reports of departments:
  Agricultural economics, ... 12*a*
  Agriculture, ... 15*a*
  Botany, ... 19*a*
  Chemistry, ... 23*a*
  Cranberry Station, ... 32*a*
  Entomology, ... 36*a*
  Horticultural manufactures, ... 44*a*
  Horticulture, ... 46*a*
  Market-Garden Field Station, ... 48*a*
  Meteorology, ... 50*a*
  Microbiology, ... 52*a*
  Poultry husbandry, ... 54*a*
  Veterinary science, ... 55*a*
Respiration of cranberries, ... 25*a*, 80
Scales, studies of, ... 36*a*
Seed work, ... 22*a*
Soil studies, chemical, ... 25*a*
  Microbial, ... 53*a*
South soil test, response of crops to potash, ... 15*a*
Soy Beans:
  Planted with corn for forage, ... 24*a*
  Response to potash, ... 16*a*
Spray materials tested:
  Aphicide, ... 37*a*
  Sulco V. B., ... 38*a*
  Sulfides, dry, as substitutes for lime-sulfur concentrate, . . . 41*a*
  White arsenic in Bordeaux mixture, ... 39*a*
Squash bug, ... 37*a*
Squash-vine borer, ... 37*a*
Station staff, ... 1*a*
  Changes in, ... 3*a*
Sterilization of tobacco seed beds, ... 34
Sudan grass as a forage crop, ... 24*a*
Sulco V. B., value as an insecticide, ... 38*a*
Sulfides, dry, as substitutes for lime-sulfur concentrate, ... 41*a*
Temperature observation work, ... 47*a*
Tobacco diseases:
  Albinism, ... 24
  Bud-scald, ... 24
  Canker, ... 25
  Damping-off, ... 23
  Hollow-stalk, ... 24
  Leaf spots, including rusts, ... 25
  Mosaic, ... 26
  Root-rots caused by Fusaria, ... 25
  Root-rots caused by Rhizoctonia, ... 24
  Sun-scald, ... 24
  Thielavia root-rot, ... 23, 27
Tobacco investigations, ... 19*a*
Tobacco investigations, progress report:
  Cover crops, ... 21
  Fertilizer experiments in progress, ... 31
  Introduction, ... 1

Tobacco investigations, progress report — *Concluded.* PAGE
- Investigations necessary, 2
- Is the tobacco crop actually failing, 3
- Miscellaneous observations:
  - High-pressure *v.* low-pressure seed bed sterilization, 34
  - Mammoth types of Cuban and Connecticut Havana tobacco, 33
  - Other root-rots, 33
  - Top-dressing tobacco seed beds with dry ground fish, 37
  - Vitality of tobacco seed, 35
- Soil relations, 13
  - Humus or organic matter content of Massachusetts tobacco soils, 19
  - Study of the reaction of normal and sick soils as indicated by the "lime requirement," 15
- Summary, 37
- Thielavia root-rot investigations, 28
- Tobacco diseases — in the field, 23
  - In the seed bed, 23
- Weather factor in growing tobacco, 4

Tobacco seed, vitality of, 35

Tobacco, supply and distribution of Connecticut valley, 13*a*

Trade, local balance of, 14*a*

Tree characters of fruit varieties, 46*a*

Variety tests:
- Cranberries, 34*a*
- Greenhouse cucumbers, 48*a*
- Greenhouse lettuce, 49*a*
- Vegetables, 48*a*

Vegetation tests:
- Apatite and barium sulfide (tile experiment), 27*a*
- Nitrogen, availability of water insoluble organic in commercial fertilizers, 27*a*
- Peat:
  - Comparison of mixtures with and without bacteria (field experiment), 28*a*
  - Comparison of mixtures with and without bacteria (pot experiment), 27*a*
  - Residual effect of mixtures with and without bacteria (pot experiment), 27*a*

Velvet bean feed for farm stock:
- Composition of velvet bean feed, 63
- Digestibility of velvet bean feed, 63
- Summary of results with suggestions, 61
- Velvet bean feed:
  - For cows, 64
  - For horses, 74
  - For pigs, 71

Veterinary science, work of department:
- Control work, 56*a*
- Correspondence, 56*a*
- Diagnosis, 55*a*
- Investigations, 57*a*
- Special problems, 58*a*

Weather observations at the Cranberry Station, 33*a*

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REPORT

OF

THE EXTENSION SERVICE

1920

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PART V.—THE REPORT OF THE EXTENSION SERVICE FOR THE YEAR ENDED NOVEMBER 30, 1920

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The Commonwealth of Massachusetts

Department of Education,
Boston, Aug. 23, 1921.

To the Honorable Senate and House of Representatives.

Gentlemen: — In accordance with the provisions of section 8 of chapter 75 of the General Laws, I transmit to you herewith, for the use of the General Court, Part V of the annual report of the Massachusetts Agricultural College for the year ended Nov. 30, 1920.

Respectfully yours,

PAYSON SMITH,
Commissioner of Education.

Massachusetts Agricultural College,
Amherst, July 6, 1921.

To the Commissioner of Education.

Sir: — On behalf of the trustees of the Massachusetts Agricultural College I have the honor to transmit herewith Part V of the fifty-eighth annual report of the trustees, for the fiscal year ended Nov. 30, 1920, this being the report of the Director of the Extension Service to the corporation.

Respectfully yours,

KENYON L. BUTTERFIELD,
President.

March 26, 1921.

President Kenyon L. Butterfield, *Massachusetts Agricultural College.*

Sir: — I hand you herewith the annual report of the Extension Service for the year ended Nov. 30, 1920.

Yours respectfully,

JOHN D. WILLARD,
Director.

CONTENTS.

PAGE

Letters of Transmittal, ... 3
The Staff, ... 7
About the Extension Service, ... 9
Projects, ... 10
Outstanding Results of Extension Work in 1920, ... 11
Summary of the Year, ... 13
Financial Statement, ... 15
Detailed Reports by Projects, ... 16
  County Administration, ... 16
  State Administration, ... 17
  Publication and Publicity, ... 18
  County Agent Work, ... 19
    Farm Management, ... 20
    Soils and Crops, ... 21
    Animal Husbandry, ... 22
    Sheep Husbandry, ... 24
    Dairying, ... 25
    Poultry Husbandry, ... 25
    Pomology, ... 27
    Horticultural Manufactures, ... 28
    Vegetable Gardening, ... 29
    Plant Diseases and Injurious Insects, ... 30
    Co-operation and Marketing, ... 31
    Forestry, ... 32
    Rural Engineering, ... 33
  Home Demonstration Work, ... 34
    Household Management, ... 34
    Nutrition, ... 35
    Food Preservation, ... 37
    Clothing Efficiency, ... 38
    Health and Sanitation, ... 39
  Junior Extension Work, ... 40
  Extension Schools, ... 42
  Exhibits, ... 43
  Extension Courses at the College, ... 45
  Correspondence Courses, ... 46
  Library Extension, ... 47
  Lectures, ... 48
  Landscape Gardening, ... 48
  Floriculture, ... 49
  Community Organization, ... 50

MASSACHUSETTS AGRICULTURAL COLLEGE EXTENSION SERVICE.

ORGANIZATION FOR 1920.

Trustees' Committee on Extension Service.

Elmer D. Howe, Marlborough, *Chairman.*
George H. Ellis, Boston.
Harold L. Frost, Arlington.
Davis H. Dewey, Cambridge.
Nathaniel I. Bowditch, Framingham.
John F. Gannon, Pittsfield.
Arthur W. Gilbert, *Commissioner of Agriculture.*

Member Ex Officio.
President Kenyon L. Butterfield, Amherst.

The Extension Service Staff.

John D. Willard, *Director of the Extension Service.*
Ralph W. Redman, *Assistant Director of the Extension Service.* [1]
L. Wayne Arny, *Supervisor of Correspondence Courses and Extension Editor.* [2]
William R. Cole, *Extension Specialist in Food Preservation.*
Laura Comstock, *Supervisor of Home Demonstration Projects.* [3]
Roy B. Cooley, *Extension Specialist in Animal Husbandry.* [4]
George L. Farley, *Supervisor of Junior Extension Work.*
Henry E. Haslett, *Extension Specialist in Sheep Husbandry.* [4]
Robert D. Hawley, *Supervisor of Extension Schools and Exhibits.* [5]
William F. Howe, *Assistant Supervisor of Junior Extension Work.*
Delos L. James, *Extension Specialist in Dairying.* [6]
Louis M. Lyons, *Supervisor of Correspondence Courses and Extension Editor.* [7]
Allister F. MacDougall, *Extension Specialist in Farm Management.*
Robert J. McFall, *Extension Specialist in Agricultural Economics.* [8]
William C. Monahan, *Extension Specialist in Poultry Husbandry.*
Earl H. Nodine, *Assistant Supervisor of Junior Extension Work.*
Helen M. Norris, *Assistant Supervisor of Junior Extension Work.*
Sumner R. Parker, *Supervisor of County Agent Projects.*
Lucy M. Queal, *Extension Specialist in Nutrition and Household Management.* [9]
Ruth S. Reed, *Extension Specialist in Clothing Efficiency.*
Marie Sayles, *Assistant State Leader of Home Demonstration Agents.* [10]
Ralph A. Van Meter, *Extension Specialist in Pomology.*

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[1] Acting Director until Feb. 1, 1920.
[2] Resigned Aug. 1, 1920.
[3] On leave of absence, one year, Oct. 1, 1920.
[4] Resigned Aug. 31, 1920.
[5] Appointed May 22, 1920.
[6] Resigned May 22, 1920.
[7] Appointed July 16, 1920.
[8] Appointed Jan. 8, 1920.
[9] Appointed July 14, 1920.
[10] Acting State Leader, Aug. 1 to Nov. 30, 1920.

SPECIALISTS TEMPORARILY EMPLOYED.

JOHN B. ABBOTT, *Temporary Specialist in Crops.*[1]
MILDRED ANNAN, *Temporary Specialist in Millinery.*[2]
MRS. ELIZABETH DAY, *Temporary Assistant in Clothing.*[3]
MRS. ANNIE L. DUNN, *Temporary Assistant in Clothing.*[4]
DOUGLAS HUNTOON, *Temporary Assistant in Pomology.*[1]
ARTHUR McCOY, *Temporary Specialist in Dairying.*[5]

HEADS OF DEPARTMENTS DEVOTING PART TIME TO EXTENSION WORK.

ALEXANDER E. CANCE, *Professor of Agricultural Economics.*
WALTER W. CHENOWETH, *Professor of Horticultural Manufactures.*
JAMES A. FOORD, *Professor of Farm Management.*
JOHN C. GRAHAM, *Professor of Poultry Husbandry.*
CHARLES R. GREEN, *Librarian of the College.*
WILLIAM P. B. LOCKWOOD, *Professor of Dairying.*
FRED C. SEARS, *Professor of Pomology.*
FRED A. WAUGH, *Professor of Landscape Gardening.*

CLERICAL STAFF.

MRS. RICHARD D. ARP, *Clerk, Extension Service.*[6]
SUSAN L. CLARK, *Clerk, Junior Extension Service.*
MARGARET G. DAVIDSON, *Clerk, Extension Service.*
FLORENCE E. DAY, *Clerk, Extension Service.*[6]
HAZEL E. DONOVAN, *Clerk, Extension Service.*[7]
GRACE E. GALLOND, *Clerk, Department of Dairying.*
KATHERINE GARDNER, *Clerk, Division of Agriculture.*[8]
LILLIAN S. HADFIELD, *Clerk, Junior Extension Service.*[7]
CATHERINE HARRINGTON, *Clerk, Division of Agricultural Economics.*[7]
KATHERINE M. HARRIS, *Clerk, Division of Agriculture.*
MARION E. HAWTHORNE, *Clerk, Extension Service.*[7]
MARGUERITE C. LEDUC, *Chief Clerk, Extension Service.*
HONORIA A. LEE, *Stenographer, Division of Horticulture.*
ALINE J. LEGARE, *Stenographer, Division of Agriculture.*
DORIS MILLETT, *Clerk, Extension Service.*[6]
GLADYS I. MINER, *Clerk, Extension Service.*[8]
CORINNE T. PETIT, *Clerk, Junior Extension Service.*
HELEN L. PHILLIPS, *Clerk, Junior Extension Service.*
JESSIE M. PRINCE, *Chief Clerk, Extension Service.*[7]
MILDRED C. PUTNEY, *Stenographer, Extension Service.*[6]
HELEN E. REARDON, *Clerk, Extension Service.*
JOSEPHINE B. REED, *Stenographer, Extension Service.*[6]
SADIE SHORES, *Clerk, Extension Service.*
MARJORIE SULLIVAN, *Clerk, Division of Agriculture.*[7]
ALINE B. SUPRENANT, *Clerk, Extension Service.*[7]
CLARA A. SWIFT, *Clerk, Extension Service.*
MRS. A. L. TOWER, *Stenographer, Division of Agriculture.*
ELLEN L. WELCH, *Clerk, Division of Science.*[7]
CATHERINE H. WHITE, *Stenographer, Extension Service.*[6]
MRS. HARLAN WORTHLEY, *Clerk, Junior Extension Service.*[7]

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[1] Employed one month seven days.
[2] Employed two months three days.
[3] Employed two months.
[4] Employed four months twelve days.
[5] Employed three months.
[6] Appointed during year.
[7] Resigned during year.
[8] Transferred.

ANNUAL REPORT OF THE EXTENSION SERVICE

OF THE

MASSACHUSETTS AGRICULTURAL COLLEGE.

ABOUT THE EXTENSION SERVICE.

A State college is a public institution and its value is measured in terms of its service to the whole people of the Commonwealth in which it is established. It has a duty toward every citizen who can use its educational resources.

The realization of this larger educational duty led to the establishment of the Extension Service of the Massachusetts Agricultural College functioning in an educational way for persons not resident at the college.

A Bit of History.

The Massachusetts Agricultural College has carried on Extension work since its earliest years. Gradually the field work of the college assumed such proportions that in 1909 it became necessary to organize a separate division to fulfill the obligations of the college to people away from the campus. This separate division became the Extension Service. In 1914 the Federal Extension Act, known as the Smith-Lever bill, made funds available from the United States Department of Agriculture for the carrying on of co-operative Extension work in agriculture and home economics in all States supporting land grant colleges. Massachusetts received $10,000 as its Federal apportionment of the money the first year, which sum has since been increased to the maximum which this State can receive from Smith-Lever funds, — $30,000, — a sum based upon the proportion of rural population in Massachusetts to the total rural population of the country.

The Legislature of 1914 accepted the provisions of the Smith-Lever bill, under which the Director of the Extension Service is made the State executive of all Extension projects for the United States Department of Agriculture. Extension work in Massachusetts has since been carried on under a memorandum of understanding between the president of the college and the United States Department of Agriculture.

An immediate result of this co-operative relationship was the shaping of all Extension work into definite projects, under which plans of work are annually submitted for the approval of the United States Department of Agriculture. Each college specialist is responsible for what is called a project, namely a written understanding that a specialized program shall be followed for the development of desirable practices in some major field of agriculture. Each project comprises a statement of the objective and of the means of working toward the goal. The project method of carrying on Extension work has made possible the gathering up of loose ends of itinerant teaching into compact educational campaigns for a more profitable agriculture.

PROJECTS.

The Extension projects are as follows: —

- Administration.
- Printing and Publicity.
- County Agent Work: —
  - Farm Management.
  - Soils and Crops.
  - Animal Husbandry.
  - Sheep Husbandry.
  - Dairying.
  - Poultry Husbandry.
  - Pomology.
  - Horticultural Manufactures.
  - Vegetable Gardening.
  - Plant Diseases.
  - Injurious Insects.
  - Co-operation and Marketing.
  - Forestry.
  - Rural Engineering.
- Home Demonstration Work: —
  - Household Management.
  - Nutrition.
  - Clothing.
  - Health and Sanitation.
- Junior Extension Work.
- Extension Schools.
- Exhibits.
- Extension Courses at the College.
- Correspondence Courses.
- Library Extension.
- Lectures.
- Floriculture.
- Landscape Gardening.
- Community Organization.
- Methods of Extension Instruction.

OUTSTANDING RESULTS OF EXTENSION WORK IN 1920.

The work with potatoes gave perhaps the most immediate returns of any Extension project the past year. The county agent leader makes the following summary report of the campaign for the introduction of northern-grown seed: —

> The results of the potato demonstrations in 1919 showed that northern-grown seed potatoes yielded at the rate of 79 bushels per acre more than local-grown seed. With this as a basis, a campaign was put on in 1920 to induce farmers to use northern-grown seed.
>
> How well this campaign succeeded is shown in the following summary of statements by 36 seed potato dealers in the State. In 1919 these 36 dealers sold 40,448 bushels of northern-grown seed potatoes; in 1920 they sold 85,512 bushels. The increase was 45,063 bushels, or about 112 per cent. The 36 dealers sold enough seed to plant 5,700 acres out of 33,000 acres in the State. The increased acreage planted to northern-grown seed in 1920 amounts to about 3,000 acres. The increased yield on 3,000 acres due to the use of northern-grown seed amounts to 237,000 bushels, and this, valued at $1.50 a bushel, would amount to $355,500, which is enough to pay the total bill of Extension work in the State and leave a balance of about $10,000.

In another single project — orcharding — immediate returns to the growers through effective and timely Extension instruction are readily computed. Aided by heavy snowstorms last winter, rodents girdled 35,000 young fruit trees in the State. The Extension Service was able to put seven specialists from the college into the field for an intensive educational campaign in bridge grafting. Within a few weeks these specialists had trained 61 men to qualify as experts and had taught 544 growers enough so that they successfully grafted their own damaged trees. Seventy-five per cent of the grafted trees were saved, or about 13,232. The average age of the trees was seven years and a conservative estimate of their value was $7 each. The value of the salvaged trees was at least $90,000, and there are 600 men in the State who have learned how to save a girdled tree.

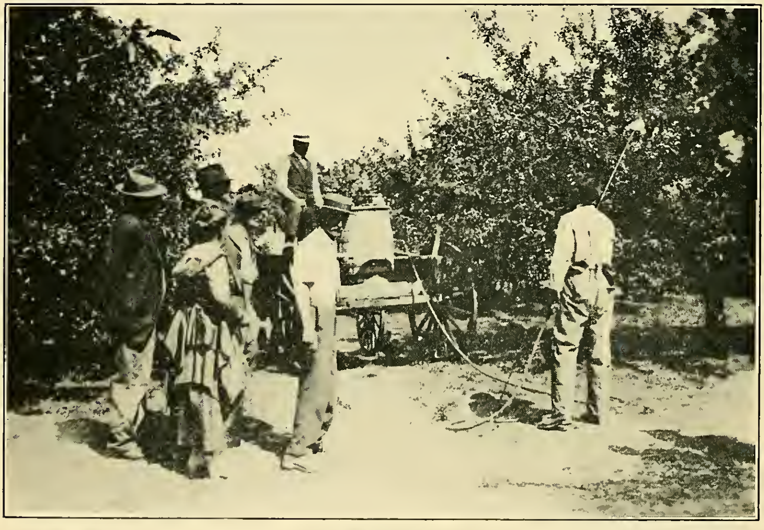
Absolute values cannot, however, be assigned in summarizing Extension Service results. The returns from more efficient management are cumulative; once convinced, the farmer profits by the lesson during the rest of his active life. No cash estimate can be placed on the power that comes to a community through the training of a group of young people to accept leadership. Only the most general statement can be made of the incalculable gain to her children from the saving of even a fraction of a mother's time from household tasks for playtime and story.

The feature of both home demonstration and junior extension work was the development of many local leaders. Two hundred and three women were trained to lead local groups in food preservation; 920 women demonstrated clothing work to classes in their communities, reaching 18,005 other women. Fifteen hundred and forty-three women kept household accounts and 405 made family budgets. A campaign for hot school lunches resulted in the equipping of 113 schools for serving mid-day lunches with soup or cocoa.

The most significant club work was the training of junior leaders. This year 17 girls took the leadership of canning and home economics clubs,. and 240 other club leaders were given instruction in seven special schools for club leaders. The development of demonstration teams advanced so far during the year that every county fair found a place for demonstrations by successful club teams. More than 20,000 other boys and girls were reached through these demonstrations.

Joint projects were undertaken in some instances by club members with their parents. Father-and-son sheep clubs and mother-and-daughter canning clubs led to a community of interest in many families not formerly realized. The most popular club in Thorndike was the Big Sister's Club, composed of women and "borrowed daughters." Efforts to maintain the interest of older boys and girls brought graded projects. Home economics club work has been reorganized on a graded plan extending over four years to the high school domestic science stage. Thirty Norfolk County canning club members completed advanced work. A success club in this county — of prize winners — completed its third year, developing leadership for the club work of the county. In Franklin County the club work was planned in community meetings with town leaders

The poultry specialist gives a chalk talk to a demonstration group on one of the poultry demonstration farms.



Getting right into the orchard with the sprayer. Lecture demonstration in orchard management.

present. Every town but one in that county had some club members and all but four towns had more than ten members. Club work is founded upon the primary agricultural interests of the community in Franklin County.

"Five years of steady activity in the home making department and in the boys' and girls' clubs have made the practice of canning fruit and vegetables almost universal in our urban centers," says Miss Minnie Price, home demonstration agent, Hampden County.

Nearly half a million people were reached directly by some form of Extension work during the year. The Summer Farmers' Week at the college, an Extension activity, was the most successful farmers' week ever held in Massachusetts, 5,000 farmers and farmers' wives attending the lecture program and making inspection trips conducted daily to the demonstration plots, orchards and farms on the college plant.

Some important projects suffered through the loss of valuable members of the Extension staff, but in no case was work altogether discontinued. Co-operation of other specialists and the interest and competent leadership of the county agents were sufficient to maintain all work started. The loss of some of those specialists who were most intimately acquainted with the agricultural conditions in the State was an insurmountable difficulty to the accomplishment of the most effective work and made impossible in some instances the obtaining of complete records.

SUMMARY OF EXTENSION WORK FROM NOV. 30, 1919, TO NOV. 30, 1920.

All activities listed were accomplished through the joint effort of college specialists and county agents. The figures of persons reached indicate work started or accomplished and contacts made.

Projects.	Persons reached.
Agriculture,	205,803
Live-stock improvement, dairying, orchard management, soil fertility, poultry husbandry, marketing, assistance to farmers' co-operatives, crop improvement, vegetable gardening, farm management, by-products manufacture and storage.	

	Persons reached.
Junior Extension,	77,584
Boys' and girls' clubs: canning, home economics, clothing, corn, garden, onion, sweet corn, potato, pig, sow and litter, poultry, calf, cow and calf, baby beef, sheep, bee, general agriculture, handicraft. Value of products, $222,912; value above costs, $114,617.	
Home making,	135,889
Food preservation, nutrition, clothing efficiency, household management, house planning, health campaigns, hot school lunches, home gardens, dental clinics.	
Total,	419,376

AGENCIES.

Farm demonstrations,	671
By farmers, on farms; applying methods of specialists; demonstration orchards, economic poultry management, farm management tours, comparative seed potato tests, hay and pasture top-dressing demonstrations, vegetable variety demonstrations.	
Fair exhibits,	160,900
91 college representatives demonstrated agricultural and home-making methods by exhibits and conferences at 30 fairs.	
Extension schools,	2,000
33 schools.	
Correspondence courses,	330
18 courses.	
Library Extension.	
374 books and 47 bulletins sent to 29 small public libraries of the State.	
Extension courses at the college,	5,300
Summer Farmers' Week.	
Lectures by agents and specialists.	
News service from the college reaches all papers.	
Bulletins and circulars to mailing lists.	
Home study groups.	
Clothing classes,	18,905
920 local leaders taught pattern and garment making.	
Community project committees.	
Boys' and girls' clubs,	20,713
10,821 club members, 559 clubs; 567 demonstrations given by club members and teams of club members.	
Farm account books,	1,900
Sold at cost to farmers to aid in business efficiency.	
Home account books,	1,543
Sold at cost to home makers as a means of introducing budget systems.	

SUMMARY STATEMENT OF EXPENDITURES, BY PROJECTS, SHOWING SOURCES OF FUNDS USED FOR EXTENSION WORK, AUG. 1, 1919, TO JULY 30, 1920.

PROJECTS.	Total.	SMITH-LEVER.		State.	Other.
		Federal and Supplementary Federal.	State and Supplementary State.		
1, 1*b*. Administration,	$14,716 24	$3,833 66	$268 15	$10,614 43	–
1*a*. Printing and distribution of publications.	2,179 78	714 97	30 10	1,434 71	–
2. County agents,	9,353 16	2,228 54	4,233 40	2,891 22	–
3. Home economics,	15,001 26	5,557 95	1,915 99	7,527 32	–
4. Extension schools and farmers' courses.	726 42	455 29	–	271 13	–
5. Junior Extension work,	17,246 68	9,192 98	3,941 52	4,112 18	–
8. Pomology,	4,284 08	1,951 35	602 94	1,729 79	–
9. Animal husbandry,	4,139 17	2,527 16	643 82	968 19	–
10. Farm management,	3,292 59	1,177 70	282 38	1,832 51	–
11. Poultry husbandry,	4,706 51	74 16	2,523 18	2,109 17	–
12. Dairying,	5,749 57	1,912 85	1,466 77	2,369 95	–
13. Library,	383 80	–	–	383 80	–
14. Local community organization,	287 22	–	–	287 22	–
15. Correspondence courses,	3,544 31	–	–	3,543 41	–
16. Lectures,	92 53	–	–	92 53	–
17. Exhibits,	5,748 54	–	–	5,748 54	–
19. Rural civic planning,	319 87	–	–	319 87	–
20. Co-operation and marketing,	4,479 72	–	1,600 16	2,879 56	–
24. Sheep husbandry,	1,188 66	287 25	556 80	344 61	–
25. Plant diseases,	221 90	–	–	221 90	–
27. Injurious insects,	38 17	–	–	38 17	–
28. Extension courses at the college,	825 15	–	–	825 15	–
29. Food preservation,	4,225 29	112 92	1,311 22	2,801 15	–
30. Home gardening,	983 68	–	650 35	333 33	–
31. Soils and crops,	3,962 38	–	–	3,962 38	–
32. Methods of Extension instruction,	711 28	–	–	711 28	–
Total expenditures,	$108,407 06	$30,026 78	$20,026 78	$58,353 50	–
Unexpended balance,	1,201 80	–	–	1,196 80	$5 00
	$109,608 86	$30,026 78	$20,026 78	$59,550 30	$5 00

DETAILED REPORTS BY PROJECTS.

County Administration.

The relations of the Extension Service to county agents and trustees for county aid to agriculture are purely co-operative. The college has no authority over either save such as arises in the voluntary partnership of the county organizations and in their acceptance of Smith-Lever funds administered from the college. Nine trustees for county aid to agriculture are responsible to the county Extension work in agriculture and home making. These trustees hire the county agents upon the approval of the Director of the Extension Service. The trustees are authorized to include in their county budget at least one-half the estimated expenses of carrying on Extension work in the county.

Towns further assist some of the county organizations by annual appropriations. As the farm bureaus were originally formed they were private membership organizations, with membership fees. Membership farm bureaus have been maintained in Berkshire, Hampden and Barnstable counties since the beginning of county work. Franklin, Hampshire, Worcester, Middlesex, Norfolk and Plymouth counties at one time had paying members, but these were not continued after 1918. In Middlesex and Worcester counties subscriptions were raised in large amounts to support this work. This did not entitle subscribers to any privileges in the organization. In Bristol and Essex counties there have been no membership organizations and the county agents have been employed by the county agricultural schools. The Norfolk County agents also are now employed by the county agricultural school.

Since 1915 there has been a State federation of farm bureaus, but the women have not functioned in this organization. In April a meeting of the New England Federation of Farm Bureaus was attended by most of the home demonstration agents and many of the county women interested in farm bureau work.

The State farm bureau is now making plans for a membership organization in every county, with a $5 family fee, except in the counties having county agricultural schools, where the fee may be only $3.

The county agents, being public officials employed in an educational capacity, have no connection with the legislative or business activities of the farm bureaus. They co-operate with these bodies, however, in the furtherance of Extension projects, and are greatly aided in their work by the organized support of the farm bureau.

The county agricultural agent, or in some counties the manager or secretary of the county organization is the director of Extension work in his county. His organization includes in every case at least three persons; an agent in agriculture, a home demonstration agent and a club agent. In some counties local funds and the county commissioners have supported larger staffs with assistants for urban work, as in Hampden County, or specialists in important branches of agriculture as in Worcester, Hampden and Middlesex counties.

The county Extension work is planned first in town project meetings, where the county agents discuss community problems with the town committee on Extension work.

The county agents assign their time to various communities and projects in proportion to the relative importance of the agricultural enterprises or the interests of home makers and club members of the county and the extent to which town committees are willing to undertake definite project work.

State Administration.

The Director of Extension Service for the State is responsible to the president of the Agricultural College and to the United States Department of Agriculture for the proper use of State and Federal funds in carrying on Extension work in the counties as provided for in the Federal Extension act and in the State act accepting its provisions. The Director supervises all Extension activities, employs members of the college Extension staff, and directs the work of this staff toward the recognized major objectives in the State program. An assistant director has immediate supervision of office administration and of finances. A county agent leader, a home demonstration leader and a supervisor of junior Extension work are responsible under the director for the projects in the three departments of Extension work.

The specialists at the college are also individual project leaders having the major responsibility for the sound development of work in their own specialties. They assist the county agents in planning and carrying out project work.

Publication and Publicity.

Extension projects have always been supported by publications of circulars or longer bulletins for general distribution. More effective support is expected from a new series of Extension publications, each a concise treatment of a specific problem, and the whole to become at least the outline of a library of agricultural practice for Massachusetts. These leaflets will be valuable as time-savers in answering letters; they should serve the propaganda needs of agricultural instruction more efficiently than larger pamphlets, in that they can be read at one sitting. The conception of the new series includes the printing of educational leaflets on home making and on science, as far as they are required to support the Extension projects. This basic literature is one of the immediate needs of the Extension Service, and is being prepared with the co-operation of many departments of the campus to meet the demand of the county workers.

News service to the papers of the State and to county Extension publications puts Extension work before many persons not otherwise reached. Articles on various phases of the food supply problems of the State have been prepared by specialists and used in many daily and weekly papers, which also receive weekly news letters from the Extension editor.

The Extension editor has found the press most receptive to articles dealing with the economics of food production, distribution or utilization, and with agricultural conditions in the State. He plans a more thorough use of the press this year than has heretofore been attempted, and counts on the co-operation of the specialists who recognize in their projects the supplementary value of news articles as well as the publicity needs of the Extension Service. Through well-planned publicity many contacts can be made from which much sound and permanent project work should result.

The Extension Service mailing lists are being revised and considerably extended as this report is prepared. Through the continued addition of names a very large proportion of the farmers of the State should be directly accessible by mail. Publications are distributed, however, only on request, except in the cases of selected lists.

County Agent Work.

Besides being a leader of all organized Extension projects in his county, the county agent is farm adviser and counsellor of all farmers' organizations in his several communities. The extent to which the county agent is called upon for advice is pretty clearly shown in the reports made of farm visits and office consultations. During 1920 the eleven county agents were called upon to make 5,742 farm visits and to meet 8,995 office calls, exclusive of many hundreds of telephone calls. Typical calls are for advice relative to the use of fertilizers, the mixing of balanced rations, the control of insect pests and crop diseases, poultry ailments, marketing difficulties and the development of co-operative enterprises. That the majority of the Massachusetts county agents have not permitted their demonstrations to suffer neglect because of the tremendous pressure of individual demands upon their time is shown in the tabulated report of their 671 farm demonstrations carried on during 1920.

On the average the county agents of the State held 81 meetings each, with an average attendance of 39 at each meeting. Each county agent averaged four Extension schools among these meetings. The average number of personal letters written by each county agent on Extension work was 1,747, and of circular letters, 1,842. Each handled an average of 20 questionnaires or other separate requests for information from the United States Department of Agriculture, the college or other official agencies.

During the year eight county agents put into operation in their offices a standard system of keeping records recommended by the United States Department of Agriculture, and the three other counties adopted a modified form of the same system.

Farm Management.

The extreme diversity of Massachusetts farming enterprises makes it impossible to apply a system of farm management to the State or to any considerable section of the State. The unit in the agriculture of Massachusetts is a farm enterprise or a group of enterprises which have proved profitable combinations for certain restricted areas, rather than a region of similar soil and market conditions. Soil types and market opportunities fluctuate within limited districts.

The Extension project in farm management comprehends a study of the principles of efficient management from the accounts kept by Massachusetts farmers, and their application to better farming. Inasmuch as there was no specialist in this project from September, 1919, to May, 1920, earlier plans were necessarily reorganized and this reorganization took much of the new specialist's time until late in the year.

He has, however, been able to serve county agents and agricultural organizations with cost account figures on agricultural industries in the State during the year, and he has undertaken work of permanent value in several principal farm enterprises. One of these is worthy of particular mention.

The Western Hampshire Farmers' Exchange, formed to improve facilities in buying and selling, includes members over an area of five towns. The farm management demonstrator, formerly county agent of Hampshire County, assisted the organization in its beginnings, and since his appointment as farm management demonstrator has worked with this group of farmers to develop the size of the business done in the district. It shortly developed that the main purpose of the organization in its first years must be to increase the size and diversity of their farm enterprises. The specialist emphasized these needs to the organization and succeeded in starting a farm account group within the exchange, whereby actual figures will be available on the volume of business in the territory of the organization.

The specialist assisted the Middlesex County agent in a survey of orchard practices in that county, from which figures will be available for a study of the orchard business in eastern Massachusetts. He worked with the Hampshire-Franklin Holstein Association to emphasize the value of quality stock in the farm business. On a tour taken by seventy-five members of the association to four farms in Franklin County, farm records of farmers who were successfully combining apple raising with live stock of high quality demonstrated the value of such a combination.

The specialist has undertaken a farm demonstration on Cape Cod through which he hopes to introduce a rotation that will sustain productivity in the thin, sandy Cape soil, which supports the most extensive strawberry trucking district of the State.

The specialist and county agents are following closely the farm account books distributed for 1921, so that the completed accounts may be collected for farm management studies. The 1921 book is of the page distribution type recommended by the Federal Income Tax Board and the Department of Agriculture at Washington. Nineteen hundred farm account books were distributed in 1920. The specialist has also assisted in the preparation of account books for boys' and girls' club projects.

Soils and Crops.

The object of all Extension work in agronomy is the more economical production of farm crops, particularly of those few main crops that may most profitably be grown in Massachusetts. To this end, demonstration teaching has been planned to bring about the production of more and better feed on the farm, adequate production of cash crops, economical maintenance of soil fertility, and the use of good quality seed of varieties best adapted to Massachusetts conditions.

Most effective demonstrations have been carried on in comparing the yields of locally grown with northern-grown seed potatoes, in determining the value of top-dressing hay lands, and in showing fertilizing treatment for run-out pastures. These demonstrations will be continued in 1921, and spraying potatoes with Bordeaux mixture will be demonstrated through the establishment of community spraying units wherever possible. Campaigns for the simplification of fertilizer recommendations and for better use of manure will be carried out in 1921.

A campaign for simplicity in fertilizer recommendations is being emphasized in all fertilizer activities of the Extension Service. Director S. B. Haskell of the Experiment Station has prepared definite and concise recommendations giving standards from which the farm operator, by analyzing his own conditions, can adapt the qualified recommendations to fit his soil requirements, his capital, and his farm management practice. All but the necessary formulæ are eliminated from the recommendations, which are made up in every case relative to the modifying factors of soil, farm practice, economic conditions, and crop adaptability.

A committee was appointed at a soil fertility school in Kingston, R. I., to work out an Extension program for better use and preservation of manure. Definite plans for building concrete manure pits and barn cellars will be the basis of the demonstrations for this conservation movement.

Correspondence with farmers on crop problems required the writing of 530 letters by the specialist. He also prepared 12 news articles on crop culture for the county papers.

Eighty-eight farm demonstrations were supervised by the specialist in this project, 31 being with northern-grown seed potatoes.

Other crop demonstrations included spraying potatoes with Bordeaux mixture, top-dressing pastures and mowings, use of lime, growing soy beans as a silage crop with corn, planting improved corn varieties, rosen rye, sweet clover, alfalfa, and early varieties of oats.

Hay, being the most important farm crop in the State and at the same time probably the most neglected, is receiving special attention. Top-dressing demonstrations, both on mowings and pastures, will be continued and extended; these demonstrations have been effective and beyond all doubt influential in spreading proper fertilizing practices.

Comparisons of northern-grown and locally grown seed potatoes will include also this year comparisons with seed one year from the north. Emphasis will be placed on the source and quality of the northern seed, which previous demonstrations have indicated are most important.

Animal Husbandry.

Extension Service in animal husbandry resolves itself into a continued effort for the introduction and maintenance of high-producing stock. There is a particular need for more pure-bred sires and high-producing females and for disease-control measures, especially against tuberculosis and contagious abortion in cows and cholera in hogs.

Economic swine management demonstrations, showing the advantage of housing hogs in portable pens, making more general use of forage crops, and marketing hogs at 225 pounds live weight instead of holding them to reach 300 pounds, will be emphasized.

The specialist in animal husbandry resigned in August; but, through effectively organized demonstrations in the counties, all work started has been maintained. A new specialist has been appointed to begin work in March.

A State Holstein association, formed in August, should have a beneficial effect upon the pure-bred sire work. Two Holstein clubs have been organized, one in Bristol County and one in the Hampshire-Franklin section, and a Berkshire association is in process of organization.

Pure-bred sire exhibits were among the most effective of the educational features of many fairs in the State. The specialist's correspondence amounted to an average of more than twenty letters a week throughout the year.

The campaign to put pure-bred sires on every farm supporting live stock will be prosecuted even more vigorously than a year ago, when 150 farmers, owners of 250 pure-bred males and 2,269 pure-bred females, pledged themselves to breed only from pure-bred stock. Dairy herd improvement will be further stimulated by the organization of additional cow-testing associations. Already two such associations in Berkshire County have shown the members and their neighbors the economy of well-bred cows, fed intelligently, according to suggestions from the tester in charge. Other cow-testing associations that lapsed during the war because of the enlistment of the testers are being revived.

The county agents render valuable service in live-stock improvement, judging cattle at local fairs, assisting in organizing sales of high-producing cattle, publishing in their county papers lists of registered stock breeders and exchanges, and securing selected animals for farmers who are ready to install pure-bred or registered stock.

Competition in dairy products with northern New England makes it essential that Massachusetts dairy farmers reduce costs of production by maximum efficiency and the use of only the most profitable cows.

Sheep Husbandry.

The sheep specialist resigned September 1, after two years in the State, and no one has been appointed to fill the vacancy. The sheep project is carried on by the county agents and will be given attention by the new specialist in animal husbandry who begins work in March, 1921.

During the time a sheep specialist was employed two wool associations were formed through his enterprise in the two largest sheep counties, Franklin and Berkshire, and both were very successful in marketing the product of their members at a distinct advantage over non-members' wool. The specialist during 1920 gave three demonstrations in shearing, two in castrating, one in docking, three in culling, one in slaughtering, and two in meat cutting. He performed two post-mortem examinations, gave eight lectures, and made 104 farm visits, 3,354 people attending his meetings.

The most telling work of the specialist was accomplished in the pooling and grading of wool by the two co-operative groups of growers. By comparison with other clips, growers have been able to appreciate the results of proper and faulty handling of wool and the gain or loss occasioned. The sheep association affords a medium for carrying on Extension projects by which county agents can continue the work started by the specialist.

An annual sheep day has been inaugurated at the college for sheep breeders of the State. Sheep shearing and judging contests and addresses by leading growers and animal husbandry teachers not only filled an interesting day's program for the growers but attracted widespread attention to the college Extension work in animal husbandry and to the problems of sheep breeders in Massachusetts.

At the Eastern States Exposition the specialist served on the sale committee for pure-bred rams, which placed 16 pure-bred rams and 54 high-grade ewes on Massachusetts farms.

Dairying.

Extension work in dairying is maintained to improve the quality of dairy products, and, by eliminating waste in handling, to make production more economical. Personal assistance has been given and will be continued in the manufacturing, processing and handling of dairy products according to modern and economical methods. Many small dairy men cannot afford to install equipment for proper handling and processing of milk, nor can they market their product to advantage. Co-operative milk-distributing plants are therefore not only economically advantageous to producers, but often of hygienic value to the consuming public. The Extension Service has materially assisted several co-operative milk organizations in beginning operations and in maintaining their plants. Co-operative organizations have made it possible for farmers to realize increased returns for their milk, and have to that extent encouraged dairying.

The Extension Service has attempted further to promote the dairying industry, and at the same time the public health, by assisting the New England Dairy and Food Council in spreading its sound propaganda for the increased use of dairy products.

Surplus milk results in uncertainty and economic loss in the dairy industry. The more effective utilization of this surplus is one of the vital needs of the industry in Massachusetts, and one that is being met to a degree in the building of co-operative milk plants, and in some instances by the taking over of distributing systems, so that the farmer or his paid employee operates the retail system of milk handling.

Poultry Husbandry.

Poultry raising engages a greater or smaller part of the attention of more Massachusetts farmers than any other agricultural enterprise; consequently, the field for personal service in the poultry work of the Extension Service is enormously large. The impossibility of meeting all individual demands led to the very definite establishment of organized campaigns and farm demonstrations earlier than in some other projects. During the past year the work of the poultry specialist was concentrated on sixty-one farm demonstrations, which were most effective in their influence upon the industry, and egg-laying contests, which served the ends of demonstration work in Essex and Berkshire counties.

Thirty-nine culling demonstrations were given, however, to more than 2,000 poultrymen. Sixty-eight lectures, 58 demonstrations and 204 farm visits, reaching more than 9,000 persons, were an active part of the specialist's program; and he also very largely managed the educational department of the Boston Poultry Show, and prepared exhibits for the larger State fairs. But his major work is measured, he feels, by the effect of the co-operatively managed demonstration poultry farms. Many of his meetings, some of his culling demonstrations, and a large number of his farm visits were to groups of interested growers who met him on these demonstration plants.

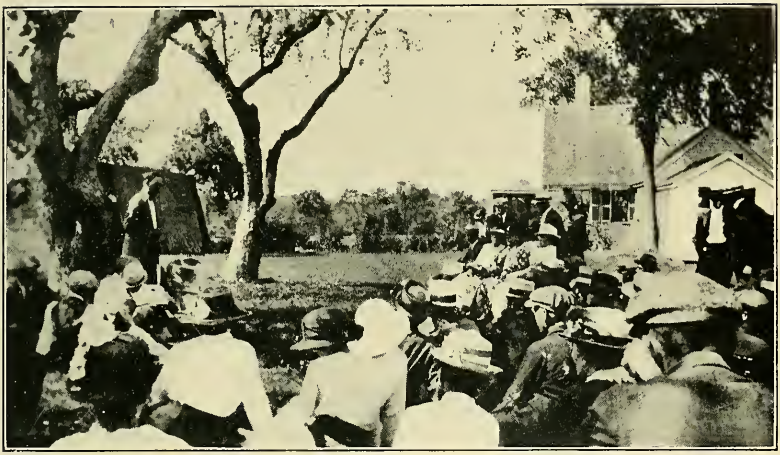
An interesting feature of the culling demonstrations this past summer was the disclosure that in almost all counties systematic culling has become a part of the general practice of commercial poultry farms.

By far the greater number of all Massachusetts hens are, however, in the hands of owners of back-yard flocks, and common commercial practice has not yet been spread among these growers. "A new method," suggests the specialist, "perhaps using home demonstration agents as a medium, may be expedient in getting knowledge regarding culling into the hands of these growers."

State-wide campaigns for systematic culling and for disease control will be conducted in 1921 in addition to farm demonstrations, which will be given special consideration in developing county and community programs. Demonstrations will include —

1. Economic management.
2. Cockerels' futurity tests (to determine the value of male birds for breeding).
3. Disease eradication.
4. Production costs.
5. Comparative demonstrations.
    (*a*) Pullets *versus* hens.
    (*b*) Artificial *versus* natural light.

Egg-laying contests will be held in Berkshire, Barnstable, Plymouth and Essex counties.



A field day with a blackboard makes a good extension school.

Owner of demonstration orchard in Norfolk County explaining methods followed in previous years.

Pomology.

Forty-eight demonstration orchards, managed under the supervision of the college department of pomology or the county agents, are the basis of demonstration work in orcharding. Four new demonstration orchards were planted in Franklin County the past year. Many of the demonstration orchards were established before the county farm bureaus were organized. During 1920 the co-operation of the county agents was secured in their supervision and in spreading their influence.

Only 13 of these demonstration orchards were established directly by the college, — the others having been started under the direction of county agents, — because the specialist was unable to undertake a personal direction of further orchard management. He visits all demonstration orchards from one to three times a year for consultation.

In the demonstration orchards the various seasonal operations are conducted as demonstrations, and are thus brought to the attention of hundreds of neighboring fruit growers, who follow their progress closely. The operations demonstrated are: pruning; spraying; control of apple-tree borers; protection of trees from mice; thinning; use of lime and cover crops; use of nitrogen; orchard renovation. In 1920 the 13 college demonstration orchards were visited by 945 people; and 146 growers, owning 50,000 trees, kept in touch with the orchard management.

Besides the permanent orchard management demonstrations, itinerant and emergency demonstration work had a very important part in the fruit program of 1920. Thirty-three pruning demonstrations, 4 spraying and 2 thinning demonstrations, held personally by the specialist, reached many people and were most successful.

The emergency feature of the year was the salvaging of a great number of young apple trees — variously estimated at from 13,000 to 35,000 — that had been girdled by mice. The college sent seven specialists into the field for a bridge-grafting campaign that covered eight counties and probably reached every orchardist who had any considerable number of trees damaged. Fruit growers came miles to bridge-grafting demonstrations. Not only the college specialist but the head of the department of pomology, an instructor in this department, both members of the department of horticultural manufactures, and two exceptionally well-prepared senior students took time from their regular work and went out to the most seriously infested communities for extended demonstration trips. Experts were also secured to do commercial grafting in badly damaged orchards.

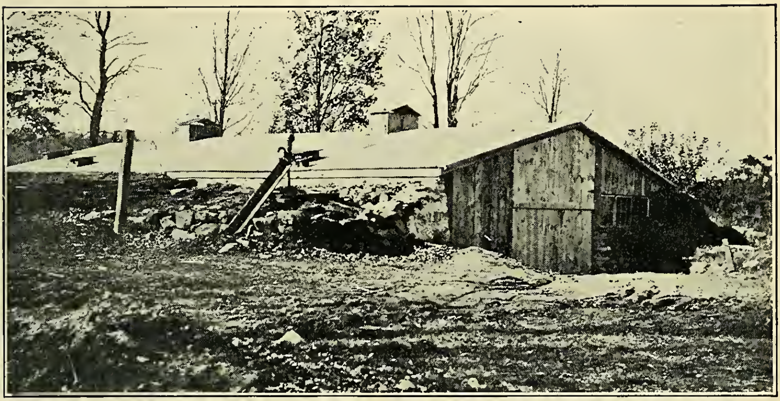
The saving to fruit growers was great; but the campaign was a splendid demonstration of the mobility of the Extension Service and of the possibility the organization offers for emergency service to farmers. Service of this nature must always be incidental and cannot be planned for; but it is the sort of thing that brings the college very close to the farmer in a way he can immediately appreciate.

Horticultural Manufactures.

Extension Service in horticultural manufactures is both home and farm demonstration work. The specialist assists the home demonstration agent in teaching home preservation and home storage, and he co-operates with the department of pomology and the county agents to teach more effective use of fruit by-products and the construction of proper storage facilities.

Farm storage and by-products manufacture, however, have commanded the major share of the specialist's attention the past year. The objectives in this department of his project are, briefly, to provide a means for marketing cull and surplus fruit, to lengthen the season of fresh fruits, and to educate the public to the value of fruit as a food. He reports 36 farm-storage demonstrations established in the State and 2 co-operative by-products plants operating, a third practically ready for work, and a fourth in the process of organization. More than 300 owners and managers of orchards were visited by the specialist, and 504 contacts with orchardists were made in storage-construction demonstrations. A demonstration of temperature control in storage cellars is under way in two counties, and investigation in machinery and construction costs has been carried on during the year.

Home storage has been an important activity of the specialist



An abandoned cellar reconstructed for apple storage on a farm in Belchertown. This demonstration was conducted by the horticultural manufactures specialist.

the past year. Three full-size storage çellars were built as demonstrations, and more than 10,000 pieces of mimeographed material besides bulletins and a series of newspaper articles were released to support the demonstrations. The specialist hopes to secure the establishment of co-operative storage of vegetables and fruits for home use among industrial employees next year in some of the larger factory communities of the State. His first efforts are being directed to the securing of full co-operation in a single plant which he can afterwards use as a demonstration.

Vegetable Gardening.

The Market Garden Field Station, maintained by the college at Lexington, serves the market gardeners about Greater Boston, carrying on demonstrations with improved strains of vegetables and in the prevention of diseases. A monthly journal of Extension work for market gardeners is issued by the Extension Service and is available to all vegetable growers. The only specialist available for service to vegetable growers is Prof. H. F. Tompson, who is head of the resident department of vegetable gardening and in charge of the Market Garden Field Station. Thus both resident teaching and research work compete with Extension activities for his time, and although he has been of inestimable assistance to market gardeners, a full-time Extension specialist is needed in this project to carry the results of the demonstrations at the field station to vegetable growers throughout the State and to assist home gardeners.

At the annual field day, instituted last summer at the field station in Lexington, nearly 700 market gardeners inspected the demonstration plots and attended discussions on vegetable-growing topics. Professor Tompson has rendered personal assistance to growers in many places about the State, making a tour of the Mansfield district to disseminate information on the control of red spider, and going to Springfield on several occasions to address the Springfield Market Gardeners' Association. Through news letters that are featured monthly in the county papers and through articles in "Extension Service News," as well as by direct approach to organized vegetable growers with the "Monthly Journal for Market Gardeners," he keeps important vegetable needs before farmers. Manure economy tests and demonstrations of tomato varieties are among the important vegetable demonstrations that are attracting attention of the Boston market gardeners at the Lexington Field Station.

Work undertaken in co-operation with the department of botany has led to the publication of two valuable leaflets on the control of vegetable diseases, one dealing entirely with the control of celery blight. The improvement of vegetable crops by the extended use of green manures, by the conservation of manures, and the better management of soils will be emphasized in 1921. Close attention will again be given the development of more productive strains of tomatoes, lettuce, and other vegetables.

Plant Diseases and Injurious Insects.

Although the departments of botany and entomology have no representative in the Extension Service, both departments have this year as always devoted a considerable portion of their time to Extension work. A correspondence course has been maintained in each subject through the Extension Service. A great amount of correspondence requesting exact information in regard to diseases and insects of crops has been referred to these departments. Both departments have prepared Extension publications during the year. The research entomologist contributed a circular on "Plant Lice" that was of service to the county agents and many fruit growers. The research pathologist, working with the head of the vegetable gardening department, has written two circulars on the control of vegetable diseases, "Celery Blight and their Control" and "Control of Vegetable Diseases by Seed Treatment."

Both departments co-operated with the Extension specialist in crops in preparing a joint Extension publication on "Potato Insects and Diseases," which is the most complete descriptive reference on potato pests that has been made available to Massachusetts farmers. Both department heads have further given largely of their time in advising the Extension editor in the preparation of publications for other departments treating incidentally of insect or disease pests.

Co-operation and Marketing.

Despite the nearness of large consuming centers, marketing presents the most insistent problem of agricultural agencies in Massachusetts. The type or the lack of type to be found in Massachusetts agriculture is evidently the underlying cause of much of the farmers' marketing difficulties. Small diversified farms, without uniformity of product even in a limited area, mean a small volume of standard commodities, and consequently offer a fundamental obstruction to successful group marketing.

Much is being done to remedy marketing ills in the State, however, and the county agents are rendering distinct service to many groups of farmers. Fifty-four farmers' co-operative marketing associations exist in Massachusetts, of which 48 were formed with the assistance of county agents. Two of the larger of these associations, which buy feeds, fertilizers, seed and other commodities for farm consumption, besides marketing the products of their members, are managed by former county agents who were largely responsible for the enterprise that made their exchanges successful.

Dairy farmers have organized rapidly during the past two years. There are now 5 co-operative milk plants engaged in marketing milk for their members. The various dairymen's groups are tending to centralize their interests and marketing management in the hands of the New England Milk Producers' Association, which makes contracts for its member organizations with milk dealers.

A new central milk plant for Pittsfield dairymen "means more to the improvement of agricultural conditions in this county than any other project that could be found," declares the Berkshire County agent.

The Hampden County Tobacco Growers' Association ended its first year of handling and selling its members' crops, the warehouse marketing 500,000 pounds valued at $200,000. This organization will serve its members with financial assistance as well as in marketing.

Seven co-operative marketing associations in Franklin County did a business of $140,000 during the year. The Hampshire

County Tobacco Growers' Association opened a new warehouse in the fall and did a $300,000 business. The Williamsburg Fruit Exchange completed its fourth successful year, acquiring a warehouse and increasing its membership.

Many of the county agents were able to render a much appreciated service to groups of farmers and co-operative exchanges by investigating sources of northern-grown seed potatoes and putting buying agencies in contact with reliable seed producers.

The following comment of the Bristol County agent gives a typical instance of such service: —

> In the spring the county agent located sources of seed potatoes and enabled the exchange to secure supplies from the Aroostook Federation of Farmers for $4.50 per hundredweight, which were delivered when potatoes were selling at practically twice that price. The saving on the car amounted to nearly $1,000.

The Worcester and Hampden Extension services co-operated with the State Department of Agriculture in maintaining market reporting and news service. The new Director of Markets of the State Department of Agriculture, a former county agent, has also co-operated most effectively with the Extension Service specialist in marketing, both agents working on an agreed program. Carrying on some phases of their marketing service jointly and others as separate projects they have avoided duplication of effort.

Much of the work of the marketing specialist during the year has been investigation of market conditions, preparation of material for the use of county agents and co-operative associations, and rendering of emergency marketing service.

Forestry.

Prof. Laurence R. Grose, forestry professor, appointed in September, has undertaken as much Extension work as his college duties permit. He has given frequent lectures before granges and other farmers' organizations in the rural parts of the State on forestry practices for the farm woodlot, and has prepared a number of valuable news articles on forestry for the "Extension Service News" and for newspaper use. He has been called upon to handle a quantity of correspondence in forestry, particularly the problems of the farm woodlot owner. He is now giving such time as he can to the revision of the existing correspondence course in forestry, with a view to making it less severely technical and therefore more serviceable to the average farmer who has a woodlot to maintain.

Rural Engineering.

Two resident instructors in rural engineering have given time to Extension work in this subject to an extent that virtually amounts to the contribution by the department of a half-time Extension specialist. Although the State authorities have declined to assign funds for the employment of an Extension specialist in rural engineering, thereby making it impossible for the college to retain a man who might devote his constant attention to farm problems in drainage, sewage disposal, water supply, building construction, and farm machinery, demands for the service of the college in all phases of this work continue to press upon the resident department.

Correspondence is a large item in this service, since typical requests for assistance require the drawing of plans, filling in details from crudely sketched tracings that are submitted for criticism. Many plans have been furnished correspondents, the greater number relating to problems of construction of drainage.

Prof. James L. Strahan held one Extension school on ventilation for dairy barns, and has since assisted many farmers on that subject. He has planned farm buildings both for individual farmers and for State institutions, the plans and subsequent supervision frequently involving trips about the State and conferences with the farm owners.

County agents assisted farmers in building 15 silos and in planning 14 drainage systems and 1 irrigation system. Two demonstration silos were erected in Essex County.

Buildings were constructed or remodeled on 19 farms from plans furnished through Extension or college agencies; 2 water supply systems were installed and 1 sewage-disposal system.

These instances of personal service to farm owners become in practically all cases the basis of Extension work. Construction planned by Extension specialists is available to neighboring farm owners, and county agents make practical use of such buildings as demonstrations.

Home Demonstration Work.

Household accounts kept by 1,543 women, family budgets made by 405 families, clothing efficiency classes attended by 18,005 women and taught by 920 local leaders, hot school lunches established in 113 country schools, nutrition work carried to 11,364 persons, more than half a million quarts of food canned by 5,324 families, — these sketchy figures tell in summary fashion something, but only a part, of what the home demonstration agents were doing in Massachusetts in 1920.

The work of the home demonstration agent falls quite naturally into five major lines of work: household management, nutrition, food preservation, clothing, health and sanitation.

Household Management.

To teach the best use of time, energy, and money, that women may have greater opportunity to take part in home and community life, home demonstration work in household management is applied to the keeping of accounts and budgets, the convenient arrangement of kitchens, the installing of labor-saving equipment and the planning of household work.

Household Accounts. — Household accounts received the major emphasis under this project in 1920. Account books issued by the college were distributed through local project leaders, who also arranged monthly group meetings for discussion of accounts, budgets, and cost of meals with the home demonstration agent and the State specialist in household management. One household account group was formed in each county and five additional groups were organized as a result of the teaching at the county demonstration groups. The specialist supplied subject-matter outlines and led the discussions on household expenses, costs of meat, food requirements of the family, and the planning of a budget. The various groups are planning budgets for 1921 on the knowledge gained through keeping accounts in 1920. Four hundred and five women made family budgets, and 3,535 were reached through demonstrations to show how to make fireless cookers, how to use cheaper cuts of meat, and how to use account books.

Kitchen Arrangement. — Kitchen arrangement is a matter in which the home demonstration agents have been called upon most frequently for assistance, and have been able to render considerable service by assisting with the planning of cupboards, shelves, grouping of utensils, and the introduction of home-made conveniences. Some women have sent diagrams of their kitchens for home demonstration agents to criticize. One woman wore a pedometer one day and decided to cut the number of miles she was traveling in two. A rearrangement of her kitchen enabled her to do so. Extension school demonstrations and talks have been aids in spreading the convenient kitchen.

Several hundred women attended demonstrations of convenient kitchen arrangement held during summer farmers' week, and many of the women were taken on an automobile tour to homes in Amherst in which kitchens had been remodeled or carefully planned for convenient arrangement.

Household Equipment. — Conferences and home economics demonstrations have led to the introduction of helpful equipment in many rural homes. Washing machines, electric mangles, vacuum cleaners and electric lighting are among the commoner improvements reported.

Household accounts, labor-saving equipment, and kitchen arrangement will be stressed in this project for 1921.

Nutrition.

School Lunches. — The securing of school lunches for 113 country schools is the most conspicuous item in the nutrition activities of the home demonstration agents for 1920. Parents and teachers are fast becoming aware of the need of the warm school lunch in maintaining the health of school children who come too far to go home at mid-day, and in most cases they are showing their willingness to co-operate for the establishment of lunch-room equipment in the schoolhouses.

Reporting on this project the Hampshire County home demonstration agent writes: —

> Until the school committees and the community show a decided interest in this project there will not be organized school lunches in our rural communities. The advantages are brought before groups continually,

and gradually the number of organized lunches is increasing. In some remote schools even drinking water has to be carried the distance of one-quarter or one-half a mile.

School lunches have gained headway in the hill towns of this county however, as the home demonstration agent goes on to report: —

> In Huntington a cup of cocoa last year has led to a lunch room, a domestic science department and a teacher this fall, with a splendidly organized lunch.

Demonstration Nutrition Groups. — A demonstration nutrition group, started during Farmers' Week among the girls who were at the college as a prize for championship club work, was continued through the summer and fall, the nutrition specialist receiving weekly reports and weight charts from each girl. Many even of these club girls were below normal weight in the summer. Every girl in the group gained, and at the time of the specialist's report ten of the twelve girls were reporting. The total gain of the group to December 1 was 97 pounds, as compared to the average total gain of children of that age of 26½ pounds.

A demonstration nutrition study group has been organized in every county, a group of underweight children being selected in a community, and mothers, teachers, school nurses and other interested persons invited to attend. The nutrition groups were formed in communities which had agreed upon a project leader to make local arrangements. The specialist assisted in the first weighing and charting of the children by the use of rhymes, fairy stories and songs extolling the value of wholesome foods. Record cards were printed and sent home with each child to be used for keeping weights, gains and foods eaten.

Milk Campaigns. — The feeding of sufficient milk with meals and in school lunches has been found a remedy for many cases of malnutrition. To increase the use of milk, particularly for children, and to emphasize the value of milk as a food, milk publicity campaigns were carried on in several cities, namely, Boston, Springfield, Worcester and Holyoke, with the co-operation of the Extension specialist in dairying and the National Food and Dairy Council, represented in New England by Prof.

Local butcher gives a home economics demonstration.

Weighing in School in Hampden County.
They join the nutrition class if they are under weight.

The local leader demonstrates in clothing efficiency.

Millinery class at home of a local leader.

W. P. B. Lockwood, professor of dairying at the Massachusetts Agricultural College.

A milk educational worker has given demonstrations in the preparation of milk dishes before groups of women's clubs and parent-teachers organizations. The National Food and Dairy Council workers have assisted home demonstration agents in introducing school lunches and in securing adequate milk supplies for schools operating lunches. Particular attention has been given this phase of nutrition work in Greater Boston, where the National Food and Dairy Council employed a full-time milk specialist late in the year, and in Springfield, where the Hampden County Improvement League has a milk specialist.

The milk specialist in Hampden County assisted eight rural schools and one small town school in establishing school lunches with milk. Extension school lunch work done in Chicopee and West Springfield resulted in the employment of permanent full-time dietitians by the West Springfield Relief Association and the Chicopee Red Cross, and in a call for similar work in the rural community of Russell.

School lunches carried on the previous year in Russell were extended to include educational work. A trained dietitian was employed to spend one day a week in the town carrying on the program of the home demonstration agent. Scales were purchased by the town and transported to schools, so that all the 250 school children were regularly weighed.

Food Preservation.

Knowledge of canning and food preservation was so thoroughly disseminated by the home demonstration agents and the department of horticultural manufactures at the college during the war that local leadership has been almost universally available in this subject. During the year the extent and the quality of this leadership was furthered by the holding of nine training classes at which 203 local leaders were instructed by the horticultural manufactures specialist of the college in new methods of preserving. Most effective exhibits were displayed at fairs, and the specialist held personal interviews and distributed information from a booth at the important fairs. Attempts to get standardization of products have been successful. A revision of Prof. W. W. Chenoweth's "Home Canning" bulletin will place the most complete directions for canning all fruit and vegetable products in the hands of home makers early in 1921.

Clothing Efficiency.

Rural women throughout the State have received the clothing instruction with an enthusiasm unequaled in Extension work in Massachusetts. The demand for instruction has exceeded the possibilities even with the strong force of local leaders developed by the clothing specialist and the home demonstration agents. The willingness of women enrolling in class work to pass along all lessons to their neighbors has been most exceptional, and has made possible the carrying of clothing work to 18,005 women during 1920.

The clothing efficiency course was prepared to solve a few of the most serious problems of the average home maker who attempts to do simple clothing work in the home. These problems were selected from the results of a survey conducted for five years previous to the undertaking of this project by the assistant State leader. The survey showed great expenditure of time, needless loss of nervous energy and enormous waste of materials in home clothing work.

The Extension classes in clothing have shown women not only how to make their clothes with great saving in time and materials, but have introduced thousands of country women to the art of planning garments for beauty, simplicity and good taste. "The clothing work has been the peg for instruction in posture and health and in general efficiency in home making," reports one home demonstration agent.

Eight hundred and twenty-four training classes for local leaders were held by home demonstration agents during the year, and 77 such groups were conducted by the clothing specialist.

The original class in a community has always been limited to a small number, five or six. Observers are admitted and the women who are later to receive the instructions from the first group are especially urged to attend to get the benefit of the group discussion.

The Middlesex home demonstration agent comments on the spread of influence of the clothing instruction as follows: —

> The instruction given in the preliminary and development courses lays a foundation for clothing work which is more valuable to the average housewife than any course given in vocational schools, correspondence courses or dressmaking schools. Teachers of normal, vocational and secondary schools are becoming actively interested in the vocational work and realize that through the application of its principles their own teaching will be greatly enriched. The clothing department of Framingham State Normal School has made it a point to have one of its members present at all the meetings of the Framingham clothing efficiency group. Their interest has been a great incentive to the women of the group and the observers. Two of them have expressed their appreciation for the work and say that they have already found its principles helpful to their own classroom work. They are especially anxious at Framingham to train their pupils so that they can go out prepared to be useful to the Extension Service.

Health and Sanitation.

Special emphasis was given by the home demonstration agent to oral hygiene and the establishment of dental clinics. Through the splendid co-operation of the State Department of Health and the Forsyth Dental Infirmary of Boston much of this work was accomplished. School nurses assisted the agents in presenting the subject in the schools. Two home nurse classes were conducted in Middlesex and Barnstable counties. Health days and two county health conferences were held to promote the interest in the counties. The weighing and measuring of children at town fairs during September and October demonstrated the need for giving special instruction in nutrition and postures.

The following results were secured: —

Dental clinics established,	21
Lectures (demonstration and oral hygiene),	94
Lectures (demonstration),	263
Fly campaign,	1
People reached through demonstrations,	22,017

Dental Clinics. — A dental clinic maintained by the Middlesex County Bureau has treated 650 school children in five rural towns in the county during the year. In two towns the work was accomplished very quickly because the mouths of the children had been put in good condition the previous year. Four other towns are now organized and ready for the clinic to come to them. Several others are making plans to organize and secure the proper financial guarantee.

A dental clinic has been maintained in the hill town of Cummington by the willingness of a Hampshire County dentist to drive twenty miles into the hills one day a week. Both grown persons and children have received dental treatment. Many of them would otherwise have gone without needed dentistry.

In Hampshire County an intensive educational campaign was carried on through the rural schools on the better care of the teeth, with the result that 104 children had dental treatment and the schools reported an increase of 40 per cent in the number of children using toothbrushes. The home demonstration agent secured the assistance of a member of the State Health Department and accompanied her to all schools visited.

JUNIOR EXTENSION WORK.

Boys' and girls' club leaders in Massachusetts feel that the most significant feature of the year in club work was the very high percentage of club members and of entire clubs that carried all projects through to successful completion. Seventy per cent of the boys and girls completed their projects and made reports. Of 10,821 club members enrolled, 7,115 made reports at the end of the year. The record number of 327 "banner clubs," that is clubs that finished with 100 per cent of their initial membership, testifies to the enthusiasm of the club members. The entire number of organized clubs was 559.

Such sustained interest is proof of the leadership. The task of the club agents has been the training of competent junior leaders. The natural teacher of boys and girls is the older boy and girl who has been an honor member of local clubs and who has found in club work a more satisfying relationship to everyday things of the home and the farm and the community. Such a graduate club member will make a successful leader of boys' and girls' work, just as the good farmer makes a successful teacher of other farmers and an efficient home maker makes a successful local leader in home demonstration work.

This year seventeen girls who had been club members assumed the leadership of home economics clubs. Two hundred and forty other club leaders were instructed in the principles of leadership at seven training schools. These local leaders were directly responsible for the success of club work in their communities. Ninety per cent of the 2,503 members of their home economics clubs completed their projects. The 59,930 loaves of bread baked by 1,021 members of bread-making clubs in Massachusetts was second in number only to the grand total bakings of the Minnesota bread-making clubs. Competing against clubs from the ten northeastern States, the bread-making and canning clubs won first places at the Eastern States Exposition, and the sewing club demonstrators were second in their class.

The demonstration value of club work was more thoroughly realized and capitalized this past year than heretofore; many county and community fairs that had not previously found a place for club demonstrations were glad to welcome the prize-winning teams with their exhibits. Not only the value of the club to the boy or girl but the subject-matter practices followed and recommended were thus brought before many thousands of people. Every club member was conducting in quite a real sense a demonstration of the value of some practice. Many parents of calf club and pig club boys have introduced pure-bred live stock on farms that were populated by scrubs. A number of mothers that had never canned fruits or vegetables have taken an interest in the canning club or home economics club work of their daughters and have become enthusiasts.

In all club work the object is primarily the teaching of boys and girls rather than the teaching of subject-matter. The value of the teaching lies in the shaping of the boy's or girl's interest about some everyday task of the farm or home, a task for which he assumes responsibility and to which his attention must be intelligently applied; the boy or girl develops with the garden or the pig or the garment or the gradually acquired skill in canning or baking better bread. He learns to do by doing. The achievement is the result of his enterprise. He keeps a record of costs; he knows how much he gains or loses;

he appreciates the value of time and of materials; he experiences the realization of ownership, or responsibility. The lessons learned in the doing are guides in future work.

Records of costs and appraisals of values of products show that club members worked on efficient business methods in 1920. The total value of products was reported as $222,912; the total costs, $108,295, leaving $114,617 as value above costs, the time of the club member having been charged against the project at an hourly rate. The potato club members and some hog club members lost money, however, in the tremendous shrinkage of farm products values. They knew they lost money and they knew why they lost it; their records showed. So that they gained something in experience from their ventures even though in some cases it may have been sophistication in regard to conditions controlling the returns from agriculture.

Efforts to correlate the work of the club members to the interests of the farm and the home have been notably successful in Franklin and Worcester counties. The result appears in the sustained interest of older boys and girls.

In club work, although prizes are given, they are made thoroughly a secondary consideration. Competition for club championships, which further competition narrows to county and finally to State championships, puts an added zest into club work which undoubtedly accounts for some excellences in the work. A much cherished vacation last summer was the week at the Massachusetts Agricultural College given more than one hundred boys and girls who won first or second prizes in county club projects. The club members attended lectures and demonstrations by members of the college faculty, judged the college herd, and enjoyed trips about the farm and to points of interest near Amherst.

Extension Schools.

Extension schools are community gatherings, under the guidance of trained instructors, for the study and discussion of local farm and home problems. Their object is to assist local farmers to meet conditions of production and marketing which are most troublesome, making clear by demonstration and experience talks the most practicable methods for applying remedies. Instructors from the college assist county agents to lead the program, which is prepared upon the initiation of a local project committee, which committee also arranges the details of managing the school. These schools serve to introduce Extension projects into many rural communities, and to emphasize needed work, which, after a successful school, the local project committee is frequently able to undertake, and thereafter, strengthened by the assistance of the county agent or the local project leader, to follow until the needed improvement has been accomplished.

Thirty-three schools held last winter had an attendance of 2,000 persons, and the interest evidenced in the 1921 schools would seem to show that Extension schools are meeting a real need in many agricultural townships.

EXHIBITS.

The many large and small fairs of the State offer a tremendous opportunity for educational campaigns in agriculture which the Extension staff have used to extend the influence of such agricultural and home economics work as was already well developed. Thirty of the college staff, half of them resident instructors, attended fairs last fall, and one specialist had personal conference with 461 persons during 25 hours' attendance at a booth at one of the larger fairs. More than 160,000 persons inspected Extension exhibits at 30 fairs, for which approximately 2,000 charts were prepared at the college to tell the story of the 110 separate features of Extension work emphasized.

Graphic descriptive material and symbols were effectively used. "The Grave of the Scrub Bull" was among the most interesting exhibits at all fairs visited. The college supplied supplementary material for county exhibits at the smaller fairs and sent specialists with all exhibit material to discuss the projects with interested inquirers.

One distinctly college exhibit, directed by the Extension Service and presented at the Eastern States Exposition, was perhaps the most effective demonstration of the college activities that has been attempted. By actual count more than 103,000 persons passed through the college exhibit and 6,000 persons asked questions of the members of the faculty in attendance at booths. Twenty-five hundred registered requests for college publications.

The home economics booth at this fair won the college a little spectacular publicity. On children's day the nutrition specialist and State leader undertook to quiet two lost infants, with such success that the local police immediately brought over all the accumulated lost children of the crowded day's mishaps. Shortly the home economics leader had a row of beaming babies, all munching bread thick with apple butter from the exhibit of the horticultural manufactures department, sitting under a placard that proclaimed a station for lost children. They were all kept happy until called for, to the relief of the special police.

The larger fairs afford unexcelled opportunities to introduce to large numbers of people the food supply problem of the State and the ways in which the Extension Service is attacking them. Emphasis at such fairs is placed on the vital needs of agricultural improvement by means of striking charts, graphics and legends.

Extension work has rejuvenated the small fairs of the State. Not only the exhibits of Extension agents, but the agricultural exhibits of farmers and home makers who have definite results to show for work undertaken in crop improvement or better housekeeping, have brought back to its historic prominence the agricultural department of the community and county fair. The fair exhibit is the logical completion of an accomplished project. The display of a local farmer's products with a legend describing the yield and the culture of the crop is probably one of the most effective means of spreading the influence of sound crop improvement. For a month or more before every fair season county agents spend their time visiting farmers who ought to be exhibitors, inducing them to make entries and teaching them how to prepare their plates, their cattle or their packs of fruit and vegetables. Several county agents are members of local fair committees and have been able to further agricultural projects by the co-operation of the fair management.

Extension Courses at the College.

Summer Farmers' Week, the last week in July, has become established as the major campus event on the Extension Service calendar. Farmers' Week visitors last year numbered more than 5,000 farmers and members of farmers' families, who inspected the college equipment, studied the crop demonstrations and the experimental plots and were interested participants in group discussions with the specialists. A lecture program filled every available hour with talks by leaders in almost every phase of agricultural production and home making.

A Polish Farmers' Day fills the place of the former Winter Farmers' Week. The special agricultural crops of the Connecticut Valley — onions and tobacco — will determine the program for the section meetings, but home-making groups are scheduled for the Polish women, whom it is hoped to interest in nutrition and household management.

The Extension Service is attempting to establish a basis of relationship with the Polish people of the Connecticut Valley counties which will enable them to take full advantage of whatever service the college has to offer them.

To this end several of the more basic publications of the Extension Service are being printed in Polish, one on "Fertilizers" and another on "Canning" having already been distributed to mailing lists of Polish people in western Massachusetts. The undertaking of farm management work with another group of foreign people — the Portuguese strawberry colony of Falmouth — has already been reported under the farm management project.

Mention has been made of clothing and home demonstration schools for county home demonstration agents held at the college. Several courses of ten days, one week and shorter periods were held in canning and preserving for students in other women's colleges and for stewards and matrons of State institutions. Many of the women students become active leaders in home economics teaching after leaving college and are sometimes able to carry the influence of Extension teaching even outside the State.

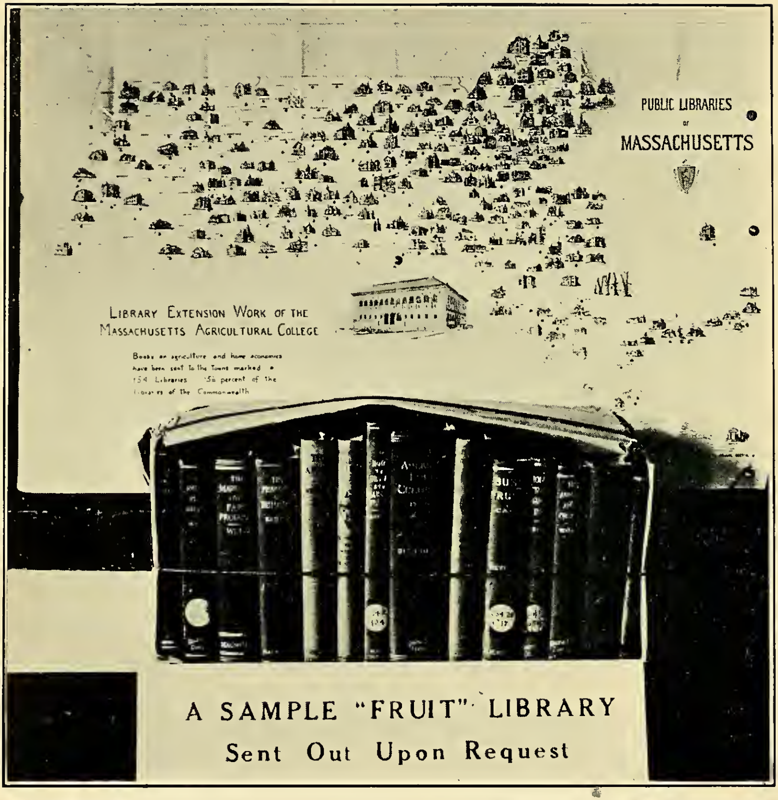
Correspondence Courses.

Correspondence courses are offered as study outlines in agriculture and home economics to persons unable to attend college. They are prepared as beginning courses for students of a specialized subject and should be a guide and an introduction to more extended reading and more exhaustive study than is contained in the lesson assignments.

Some of the existing courses will be revised during the year, to introduce new reference books and to include in the study outlines more of the economics of agricultural production and marketing applied to Massachusetts. The projects of the subject-matter specialist will be followed in outlining new courses, and the problems they are emphasizing in farm demonstrations will be presented. It will be the aim in each new course to state briefly the condition of the industry and the opportunities for its development in Massachusetts, then to indicate the problems involved and to outline a course of study based upon textbook reading and supplemented in each lesson assignment with an article by a specialist, that will show the application of the text to Massachusetts agriculture.

Lectures to study groups are arranged when possible. Correspondence course students are kept in touch with other Extension Service activities and are sent publications related to their studies as they are issued. The Library Extension and the local farm bureau are used on every possible occasion to make courses of greater value.

Under the auspices of the correspondence course department two intensive lecture courses are being given in Springfield as this report is written, one on "Vegetable Gardening," to a group of about 100 members of the Springfield Garden Club, and the other on "Planning the Home Grounds," to a landscape gardening club of about 60 members. Five members of the division of horticulture are assisting in the landscape gardening course of eight weekly lectures planned by Prof. W. E. Philbrick, Extension specialist in landscape gardening. The material used in these talks will be incorporated in a correspondence course outline on "Home Grounds" at the end of the course.


PUBLIC LIBRARIES
OF
MASSACHUSETTS
LIBRARY EXTENSION WORK OF THE
MASSACHUSETTS AGRICULTURAL COLLEGE
Books on agriculture and home economics
have been sent to the Towns marked ●
154 Libraries
percent of the
libraries of the Commonwealth
A SAMPLE "FRUIT" LIBRARY
Sent Out Upon Request

Such traveling libraries were sent to 29 small town libraries last year. They were a great help to people who began studies at the Extension Schools.

The correspondence course office is also responsible for a series of lectures on "Flower Gardens," supplemented by home study, given by Prof. Clark Thayer to the Southampton Home Economics Club.

A new course on live stock is being prepared by the Division of Animal Husbandry; the course in home economics and the three courses in agronomy are undergoing revision by members of those respective departments. Enrollment in the correspondence courses for 1920 was 512.

Library Extension.

Correspondence Course students and persons who wish to follow up their studies at Extension schools are enabled to secure the most up-to-date and thorough texts on all subjects taught at the Agricultural College through the Library Extension. The college librarian sends cases of books on request to the small public libraries of Massachusetts, express prepaid, and pays the return transportation. Many people have been able to complete reference readings and undertake advanced study in correspondence courses who without the use of the college library could not have afforded the recommended course of study.

The library could serve many more people than it does with a slight addition to the clerical force; its needs are not for any improvement in the grade of service rendered, but for facilities to increase the scope of that service. When the librarians in rural Massachusetts are more familiar with its service, the "M. A. C. Traveling Library" will be a boon to every small town librarian in the State.

An instance of the type of informal library service rendered occurs as this report is being prepared. A representative of the Federal Board of Rehabilitation wrote the Extension Service that about 100 convalescent service men were at the Glenrock Hospital, Malden, Mass. Some of the men were planning to change their vocations upon their discharge and were eager for information on forestry and poultry; others were without magazines and books and seemed likely to be interested in any material that might be sent. The request was referred to the college librarian who reported as follows: —

The shipment sent from the library contains some of the latest and best books on various phases of agricultural work, some of the most attractive farmers' bulletins on these same subjects and a few farmers' periodicals.

Library leaflets, prepared by the librarian in co-operation with other departments, have enabled the Extension Service to provide lists of the best books on various branches of agriculture to all interested students, farmers and home makers. Guidance to profitable reading has thus been introduced in hundreds of farm homes.

Some of the Library leaflets are: —

Good Books for Poultrymen.
Good Books for Dairymen.
Good Books for Vegetable Gardeners.
Good Books for Farm Women.
Good Books on Horticultural Manufactures.
Good Books on Farm Machinery.
Good Books for Fruit Growers.

Lectures.

Had the Extension Service no agricultural program for development it could keep its staff occupied merely meeting requests for lecturers. Attempts are made to send lecturers to agricultural organizations in so far as is reasonably possible and consistent with progress in definite project work. Whenever possible, lectures are turned into analysis meetings to start the community or group on the task of meeting some recognized agricultural or community need. Lectures to boards of trade and to business and educational organizations frequently lead to the development of project work. A minimum of such contacts must be undertaken if Extension work is to reach new groups of people.

Landscape Gardening.

With the appointment of a specialist in landscape gardening, to take effect January 15, the Extension Service is prepared to go forward with work undertaken before the war, — assisting village improvement societies and other community organizations in town planning and civic improvement through the beautification of public grounds, roadside plantings, arrangement of public buildings, planting of school grounds, and development of recreation centers and town commons.

Already several towns are waiting for the service of the landscape garden specialist to plan public improvements. This work will be confined strictly to public enterprises.

Floriculture.

Demands for Extension work in floriculture have been almost exclusively in the home garden side of the subject. The resident college courses deal altogether with commercial floriculture. Extension activities have, therefore, entailed the addition of an essentially different subject to the resident work of the single floriculture professor. Prof. Clark Thayer has been able to accomplish a considerable amount of Extension work. He has co-operated with the home economics specialists in all women's programs at the college, and his lectures on the home gardens and on flower arrangement have been among the most popular and valuable given. He has prepared a special course of home garden lectures and study outlines for a series of weekly meetings with the Southampton Home Economics Club, where he is giving fortnightly instruction to thirty home makers. He is also preparing two lectures as a part of a lecture study course to be given this winter to the Springfield Garden Club, — a group of suburban home owners who are interested in making more attractive home gardens; and he is assisting the correspondence course study group in landscape gardening in Longmeadow. Professor Thayer's lecture outlines will become of permanent Extension value in the form of a correspondence course in "Home Grounds," to be prepared in the spring of 1921. He is already handling a correspondence course in "Commercial Floriculture."

Prof. Frank A. Waugh, head of the division of horticulture, has also devoted a large part of his time to Extension Service in home grounds, although his major interest is in community development and in the landscape gardening activities of civic associations.

COMMUNITY ORGANIZATION.

The strength of Extension work in Massachusetts is the organization of local leaders and community groups to accept responsibility for the development of projects. The fact that 671 farm demonstrations were carried on in Massachusetts last year was possible only through the co-operation of successful practical farmers about the State. The reaching of 135,000 women with the home demonstration agencies came about through the interest of efficient home makers in rural communities, who attended classes for local leaders and thereafter assisted the home demonstration agents by distributing literature, advising neighbors and leading study groups, being in a sense local home demonstration agents.

Nor should it be forgotten that the members of the junior clubs in agriculture and home making are demonstrating better practices, as well as performing useful tasks.

It is not to be expected that all farmers and home makers will change to better practices or that the majority will change in a moment. The significant facts are that demonstration of better practice is now being carried out by individuals scattered through the State; that the better farmers and home makers are adopting the practices demonstrated; and that many of these practices have been written into the programs and objectives of organizations representing the most vigorous elements of our rural population.